GOVERNMENT OF MALAYSIA

VOLUME III

SECTORAL REPORT

7 : PUBLIC AWARENESS AND EDUCATION

8 : LOSS REDUCTION MEASURES

9 : EMERGENCY PREPARDNESS RESPONSE AND RECOVERY

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NATIONAL SLOPE MASTER PLAN (PELAN INDUK CERUN NEGARA)

JKR

SEPTEMBER 2009

LIST OF ACRONYMS

Bahasa Melayu		English	
Ayat-Ayat Teknikal		Technical Terms	
		AAD	Average Annual Demages
		AAL	Average Annualized Loss
		ACEM	Association of Consulting Engineers, Malaysia
		ADD	Average Annual Damages
		ADMIT	Asian Disaster Mitigation Training Network
		ADPC	Asian Disaster Preparedness Center
		AEG	Association of Engineering Geologist
		AGS	Australian Geo Mechanical Society
		AMSA	The Australian Maritime Safety Authority
		ArcGIS	Geographic Information System Software
		AUD	Australian Dollar
	Lembaga Jurutera Malaysia	BEM	Board Of Engineers Malaysia
		BRO	Borders Road Organization
		BTE	Bureau of Transport Economic
		CATs	Catastrophe Bonds
		CBA	Cost-Benefit Analysis
		CDMRC	Carribbean Disaster Management and Resource Centre
		CEDD	Civil Engineering and Development Department
		CFA	Country Fire Authority
		CIDB	Construction Industry Development Board
		CLP	Canada landslide Project
		CPD	Continuous Professional Development

		CRISP	Centre for Remote Imaging, Sensing and Processing
		DDMRC	District Disaster Management and Relief Commitee
		DFEM	Discrete Finite Element Method
		DHS	Department of Homeland Security
JPS	Jabatan Pengairan dan Saliran	DID	Department of Irrigation and Drainage
		DLP	District Local Plans
		DMC	Disaster Management Centre
JAS	Jabatan Alam Sekitar	DOE	Department of Environment
		DPRI	Disaster Prevention Research Institute
		ECC	Emergency Control Centre
		ECLAC	Economic Commission for Latin America and the Caribbean
		ECLAC-UNDP-PIOJ	Economic Commision for Latin America and the Caribben-United Nations Development Programme-Planning Institute Of Jamica
		EDGS	Enhance Data GSM Evolution
		EMA	Emergency Management Australia
		EMERCOM	Emergencies and Elimination of Consequences of Natural Disasters
		EMP	Environmental Management Plan
		EMS	Emergency Medical Centre
		EPA	Environmental Protection Agency
		EPC	Emergency Preparedness Canada
		FEM	Finite Element Method
		FEMA	Federal Emergency Management Agency
		FHWA	Federal Highway Administration
		FIT	Flood Information Tool
		FORM	First Order Reliability Method
		FOSM	First Order Second moment Approximation

		FYMP	Five Year Malaysia Plan
		GDP	Gross Domestic Product
		GEO	Geotechnical Engineering Office (Hong Kong or Brazil)
		GSI	Geologist Survey of India
		HAZUS	Natural Hazard Loss Estimation Methodology
		HKD	Hong Kong Dollar
		HKIE	Hong Kong Institution Of Engineers
		HPC	A High Powered Committee on Disaster Management
		ICL	International Consortium Landslide
		ICS	Incident Command System
		ICSM	Inter – governmental Committee on Slope Management
		ICT	Information And Communication Technology
		IDLHZ	Inventory / Database on Landslide Hazard Zone
		IDMC	International Ministerial Committee for Disaster Management
		IEM	The Institute of Engineers Malaysia
		IMF	International Monetary Fund
		IRPA	Intensified Research In Priority Areas
		ITC	Geoinformation Science and Earth Observation
		LiDAR	Airborne Light Detection and Ranging System
		LIP	Landslide Interoperability Project
	Had Cecair	LL	Liquid Limit
		LMS	Landslide Motion Survey
		LREIS	Laboratory of Resources & Environmental Information System
	Langkah - Langkah Pengurangan Kerugian	LRM	Loss Reduction Measures
	Agensi Remote Sensing Negara	MACRES	Malaysian Centre For Remote Sensing
		MEHMS	Malaysian Engineered Hill Slope Management System

LLM	Lembaga Lebuhraya Malaysia	MHA	Malaysia Highway Authority
KEMENTAH	Kementerian Pertahanan Malaysia	MINDEF	Ministry of Defence
		MINT	Malaysian Institute for Nuclear Technology Research
		MLIT	Ministry of Infrastructure, Land and Transport
		MOSTI	Ministry of Science Technology And Innovations
		MTD - RC	Mountainous Terrain Development Research Centre
		NADII	National Disaster and Information Management
		NASA	National Aeronautics And Space Administration
		NASEC	National Soil Erosion Research Centre
	Badan Bukan Kerajaan	NGO	Non-Governmental Organisations
		NIBS	National Institute of Building Sciences
		NPV	Net Present Value
MKN	Majlis Keselamatan Negara	NSD	National Security Division
		NTES	Northern Territory Emergency Service
		PIAM	Persatuan Insurans AM Malaysia
JKR	Jabatan Kerja Raya Malaysia	PWD	Public Works Department
		QRA	Quantitative Risk Assessment
		RAM	Victorian Rapid Appraisal Method
		RCL	Research Centre on Landslide, Japan
		RM	Ringgit Malaysia
		ROs	Regional Slope Engineering Centres
		RSDM	Russian System on Disaster Management
		SAIS	Slope Asset Information System
		SAR	Search And Rescue Operation
		SDMRC	State disaster Management and Relief Committee
		SEA	Slope Engineering Agency

		SEDC	State Economic Development Corporation
		SEPU	State Planning Unit
		SIMS	Slope Information Management System
		SIS	Slope Information System
		SMART	Special Malaysia Disaster Assistance and Rescue Team
		SSO	State Secretary Office
		SSP	State Structure Plans
		TCPA	Town & Country Planning Act
		TCPD	Town & Country Planning Department
		TDMA	Time Division Multiple Access
		TEC	Total Estimated Cost
		TEMAN	Total Expressway Maintenance Management Network
		TSA	The Slope Agency
PBB	Pertubuhan Bangsa - Bangsa Bersatu	UN	United Nations
		UNDP	United Nations Development Programme
		USD	United States Dollar
		USGS	United States Geological Survey
		VPN	Virtual Private Network
		WWF	World Wildlife Fund
ATM	Angkatan Tentera Malaysia		Malaysian Armed Forces
CKC	Cawangan Kejuruteraan Cerun, JKR		Slope Engineering Branch, PWD
DBKL	Dewan Bandaraya Kuala Lumpur		Kuala Lumpur City Council
IKRAM	Kumpulan IKRAM Sdn Bhd		
JBPM	Jabatan Bomba dan Penyelamat		Fire and Rescue Department
JKM	Jabatan Kebajikan Masyarakat		Department of Social Welfare
JMG	Jabatan Mineral dan Geosains		Minerals and Geoscience Department

JMM	Jabatan Meteorologi Malaysia		Malaysia Meteorological Department
JPA3	Jabatan Pertahanan Awam		Department of Civil Defence
JUPEM	Jabatan Ukur dan Pemetaan Malaysia		Department of Survey and Mapping Malaysia
KPKT	Kementerian Perumahan dan Kerajaan Tempatan		Ministry of Housing and Local Government
MPAJ	Majlis Perbandaran Ampang Jaya		Ampang Jaya Municipal Council
PBSM	Persatuan Bulan Sabit Merah		Malaysian Red Crescent Society
PDRM	Polis Diraja Malaysia		Royal Malaysian Police
STMB	Syarikat Telekom Malaysia Berhad		
TNB	Tenaga Nasional Berhad		
UiTM	Universiti Teknologi MARA		
UM	Universiti Malaya		University of Malaya
UPM	Universiti Putra Malaysia		
USM	Universiti Sains Malaysia		
UTM	Universiti Teknologi Malaysia		
UPC	Unit Pengurusan Cerun		
RTM	Radio Television Malaysia		

7. PUBLIC AWARENESS AND EDUCATION

7. PUBLIC AWARENESS AND EDUCATION

7.1 Overview

7.1.1 Introduction

It is well known in disaster management circles that a public that is well-prepared for disasters is one that has greater disaster resilience. With this in mind, preparing the public for such calamities should be accorded high priority in disaster planning. As stated by the Alabama Emergency Management Agency in the United States , "the time a disaster hits is not when the public needs to hear this information for the first time."

In Malaysia, the need for dialogue between the public and government agencies is felt whenever the media highlights slope failure occurrences throughout the nation, focusing not only on the major catastrophes such as the Highland Towers or Taman Hillview events, but on the minor albeit consistent coverage of residents complaining about creeping debris flow into their back yards or about impending commercial development on a neighborhood slope. Such events serve as reminders that public awareness and education, in addition to public information, is key to a viable slope management plan.

The messages and the content of the educational programme may vary among countries, but generally they address the four W's: who to report to, what residents can do, when and where landslides are more likely to occur, and why the public should care about prevention measures. Gaining public understanding and acceptance is paramount to success, as expressed by an Oregon emergency management agency which states that there can be an exceptional plan, but if the public doesn't understand it, "it's just going to fall apart."

7.1.2 Objectives

The objectives of the public awareness and education plan are as follows:

- To create awareness of landslide hazards and risks
- To provide education on preparedness, mitigation, response, and recovery measures

The objectives can be attained by:

1) Establishing an information dissemination system in which accurate and relevant information on landslide prevention and mitigation is constantly disseminated through appropriate channels
2) Developing the custodian agency's capability to provide technical assistance, advice, and consultation to target groups
3) Building and promoting the public communication capability of the Agency
4) Managing the prompt and accurate dissemination of public information during a landslide incident
5) Measuring the public's level of knowledge, attitudes, and propensity to take action for baseline and programme performance purposes

7.2 Problem Statement

7.2.1 Current Situation

Public awareness and education on slope safety does exist in Malaysia, although it is carried out largely by the public interest groups such as community-based organisations and NGOs. A watershed campaign that created a civil society awakening was the 1990 campaign against a hillside development on Penang Hill. Located in an area widely known within the public as a green lung within the city, the proposed development—which would consist of a waterworld complex, a condominium, an 'Acropolis' complex and an adventure park—upset the residents who felt that such development would adversely affect the environmental and aesthetic features of the hill. The flashpoint in the furore that ensued was over the supposed designation of the development by the proponents as "eco-friendly" and "green", which many groups including the Consumers' Association of Penang, the Malaysian Nature Society, Sahabat Alam Malaysia, and the USM Academic and Administrative Staff Association, felt was a sham. In a 'Samson and Goliath'-like campaign that made coordinated use of information dissemination through slide shows, forums, pamphlets, concerts, hikes, T-shirts and badges, the Malaysian public prevailed over a large corporate developer (Berjaya Corporation) and the local and state government powers. A key lesson learned by the public from their campaigning is that the power of ordinary people can stop projects deemed to be against public and environmental interests. In a 1996 seminar paper titled "The Penang Hill Controversy", the author—a legal advisor for the Consumers' Association of Penang—stated that "peoples' [sic] mobilisation and action can effect changes in society and it is this realization that is critical."

Today, this realisation is well actualised, and there are numerous similar campaigns being launched by various public interest groups around the country, but predominantly in the Klang Valley. Information on campaigns such as "Save Melawati Hill" are disseminated through websites, blogs, broadcast and print media, and public events. Making use of tactics usually employed by NGOs, the public interest groups and a more vigilant media have managed to make slope safety and hillside environmental issues ever-present within the consciousness of the Malaysian public.

However, because awareness campaigns have been initiated and practiced mostly by the public, and because they are single event-based, the campaigns are short-lived and thus ad hoc.

With the growing buzz of discontent among the public, the Government has taken steps to engage in public programmes of its own. For example, the Selangor State Government has begun to engage members of the public in public participation sessions in deciding whether the state should continue to uphold its moratorium on hillside development on hills above 25 degrees.

Similarly, the Slope Engineering Department is intent on engaging a public awareness and education campaign that is pro-active (not reactive on incident-basis) and sustained over the long term. In addition to the dissemination of knowledge-building information on the phenomenon of landslides and tips on slope maintenance, the key message will be that there is a government agency dedicated to watching out for the interest of environmental sustainability and public safety.

7.2.2 Needs

Group discussions with members of the general public in high-risk communities in the Klang Valley revealed a great need for public awareness on slope safety and a general consensus that it was high time for such a programme. However, quite a number of interviewees felt that the programmes should not solely be targeted to the general public. They stated that while it was important for the public to be educated, it was also vital that education should extend to agencies overseeing the management of slopes such as the federal, state and local governments and to developers. They felt that guidelines and laws regulating slopes exist, but not always followed during the approval, design and construction of hillside development. Terms such as "sustainable and equitable development", whereby the benefits of one development should not be attained at the expense of its neighbouring or adjacent areas, were mentioned. Suggestions were made that there should be awareness programmes for the authorities and developers on sustainable development, followed by actions by the local councils that they are enforcing the various relevant acts. As for the public, it was felt that they would like to be educated on their rights as homeowners and residents in risk areas.

On the other side of coin, engineering departments at local authorities in various states around the country stated that they would like to know more about guidelines, particularly on slope design and maintenance. Some of the authorities stated that they are addressing slope problems only when failures occur as they find it difficult to monitor slope conditions. Of the constraints they faced in management of slopes, they cited lack of manpower, lack of funds, and lack of technical expertise. They acknowledged that slope management was being conducted "piecemeal," and would like to have a more consolidated approach. Some of the engineers also stated their unease over the idea of a public awareness and education programme on slope safety, saying that it will result in more questions and queries from the public to the authorities.

Discussions with both the public and the local governments also revealed that there was little awareness of the existence of a government body to regulate slope safety and management, namely the Slope Engineering Department. They were of the view that the Public Works Department oversees slopes along roads and highways, while IKRAM oversees slopes closer to residential and commercial areas. While this is in part correct, there is a need to highlight the Slope Engineering Department's role as the authority on guidelines and practices for regulating slope design, construction and maintenance for all slopes throughout the country.

7.2.3 Constraints

As stated in the previous section, the constraints in implementing a public awareness and education programme is the general perception that local authorities are not heeding the existing guidelines and acts regulating slope management. Whether this is in fact true or even fair, perception is sometimes the reality for the general public, and this points to a need for the Slope Engineering Department to support and work closely with the local authorities in the country.

As for the constraints faced by the local authorities on the issue of funding, manpower and expertise, these problems may be in fact alleviated by the realization that there are private consultants specializing in geotechnical engineering and that the Slope Engineering Department can be instrumental in assisting the local authorities in identifying the specialists for hillside developments that require such expertise.

7.3 Detailed Study

7.3.1 Assumptions and Understanding

Before detailing the methods and messages to be imparted in awareness programmes, it is necessary to understand the basic role of the public awareness and education function in the disaster management timeline (shown below). The disaster management timeline delineates the phases before, during, and after a disaster.

As public awareness and education is a 'preparatory' activity, most of the activities occur in the Preparedness and Mitigation phase. However, there are some activities in the three other phases as explained below.

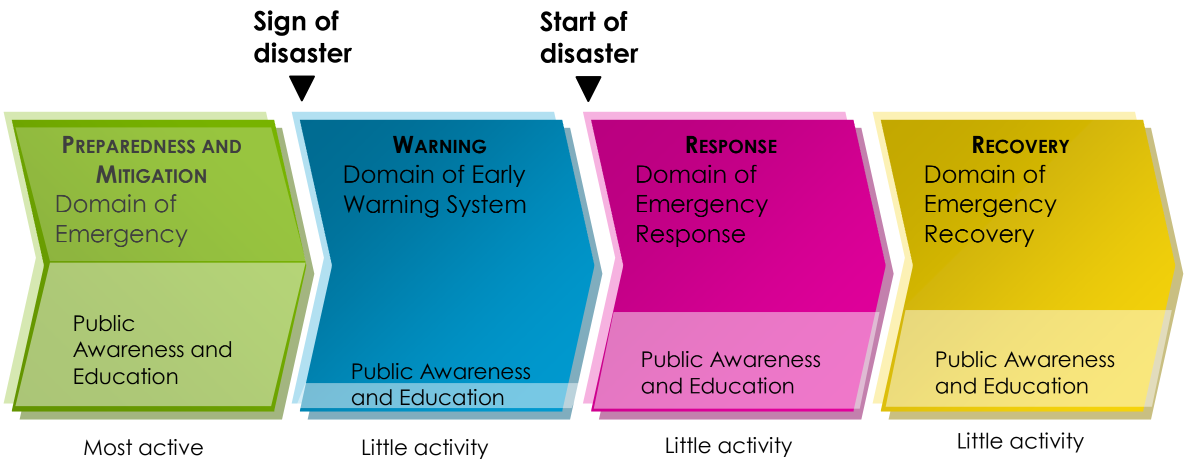

Figure 7.1: Role of Public Awareness and Education along the Disaster Management Timeline

During Preparedness and Mitigation

This is where there is the most public awareness and education activity. The primary function of public awareness and education at this phase is to provide education to reduce the occurrences of slope failures and when they do happen, to lessen the impact of landslides. As mentioned in this report, the Agency will initially take an advisory role in this function and will provide recommendations and advice to the various target groups but it will not engage in any enforcement.

During Warning

The Early Warning function will be activated, and there is no public awareness and education activity at this stage except to observe whether the messages disseminated to the public during the Preparedness and Mitigation phase are being heeded. The effectiveness of the public awareness and education function will be monitored in real-time through observed response rate to the warnings and public information as well as the public's behavior.

During Response

The Emergency Response function takes over. There is no public awareness and education activity at this stage, but the public information function becomes important as public announcements by authorities are made for the purpose of search and rescue, alerting of imminent further danger or probability of landslide recurrence, and public order. Public awareness and education shall also ensure that lines of communication between the official incident spokesperson and the Agency are open during this time so that appropriate and accurate announcements to the public and the media can be made.

During Recovery

The Recovery function becomes operational. Again, public awareness and education's role at this stage is to ensure that communication lines are open to the incident spokesperson. The public awareness and education team will also take note of failures in communication breakdown, inability of the public's capability to react, or otherwise act on safety or emergency measures the public was taught during the education process.

7.3.2 Definition of Key Words

An explanation of key terms promote further understanding of public awareness and education concepts. Listed below is a basic glossary of terms.

Disaster resilience

The ability of a community to recover from a disaster through emergency preparedness, quick response, and timely resumption of livelihood.

Public education

Includes public awareness, education, and outreach activities. Public education is ongoing, long-term, and strategic, and forms the foundation for effective public information during a disaster.

Public information

Is real-time, incident-specific and functions as part of a jurisdiction's incident management system.

Target Audiences

The notion of multiple audience segments of the public is important in public relations and public awareness practices.

There are two notions of 'public': a 'general public' and a 'special public.' Awareness and education tactics for the general public are for a mass audience and the content is therefore generic. Tactics for special public are tailored to the needs and objectives for a particular group, for example, students, local authorities, media, and real-estate developers.

In this Study, there are seven target segments identified for messages (public-at-large, professional, commercial, NGOs, academia, media, and government).
The following figure shows the terms used in context.

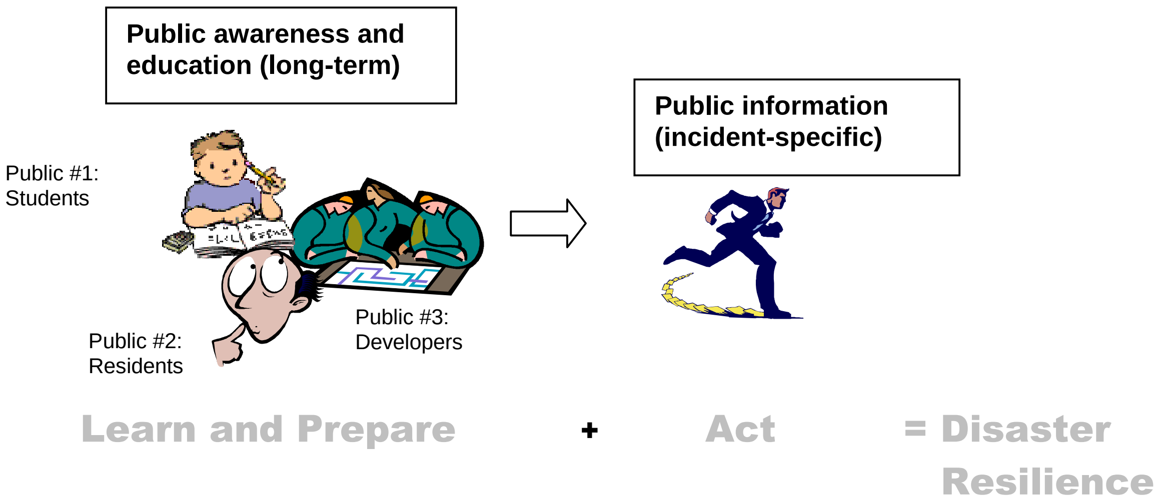

Figure 7.2: PAE key terms in context

Public awareness

The processes of informing the general population; increasing levels of consciousness about risks and how people can act to reduce their exposure to hazards. Public awareness activities foster changes in behavior leading towards a culture of risk reduction. This involves public information, dissemination, education, radio or television broadcasts and the use of printed media, as well as, the establishment of information centers and networks (UN ISDR terminology, 2003)

Education

Education is the transmission of knowledge (Teacher's Mind Resources, 2002)

Education is knowledge construction; a process of helping people become empowered (University of Illinois, Anthropology Department in conjunction with FEMA's Emergency Management Institute)

Education is presented in two modes: formal and informal. Formal education is classroom-based, provided by trained teachers. Informal education happens outside the classroom, in after-school programmes, community-based organizations, museums, libraries, or at home (Corporation for Public Broadcasting)

The hierarchy of the terms is slightly confusing—in some definitions, education falls under public awareness, while in others public awareness goes under education—but the difference between the two terms is clear: public awareness is the driving force that leads to education, which results in the desired behavior change by the public.

Figure 7.3: Dependencies for Societal Change

7.4 Findings from International Experiences

7.4.1 PAE Function in Other Countries

In general, literature review indicates that many countries worldwide have a dedicated agency for providing public education, advisory, and monitoring and warning services as support to the local/regional authorities so that engineering works, disaster response, and recovery activities. Examples are the Geotechnical Engineering Office (GEO) in Hong Kong, the Infrastructure Development Institute for the Ministry of Infrastructure, Land and Transport (MLIT) in Japan, and the U.S. Geological Survey (USGS).

For messages and public information during disasters, these agencies have direct access to the media and the public, as speed of communication from the monitoring stations to the control center to the media and the public is paramount in order the entire warning system to work.

What many of the organizational models show is that there is a dedicated agency to provide geotechnical domain expertise and knowledge, public education programmes, and awareness techniques to disaster management agencies such as the local authorities, state agencies, and disaster response organizations.

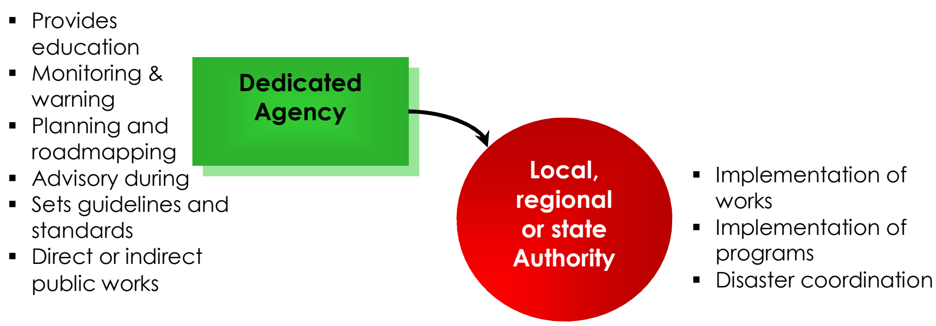

Figure 7.4: Relationship between Slope Agency and Government Agencies

Hong Kong

The public awareness and education function is carried out by one of the eight departments within the Geotechnical Engineering Office (GEO) organization. The department in charge is called the Slope Safety Division and is managed by a Chief Geotechnical Engineer. The public awareness staff is supported by PR and media consultants as well as by the universities.

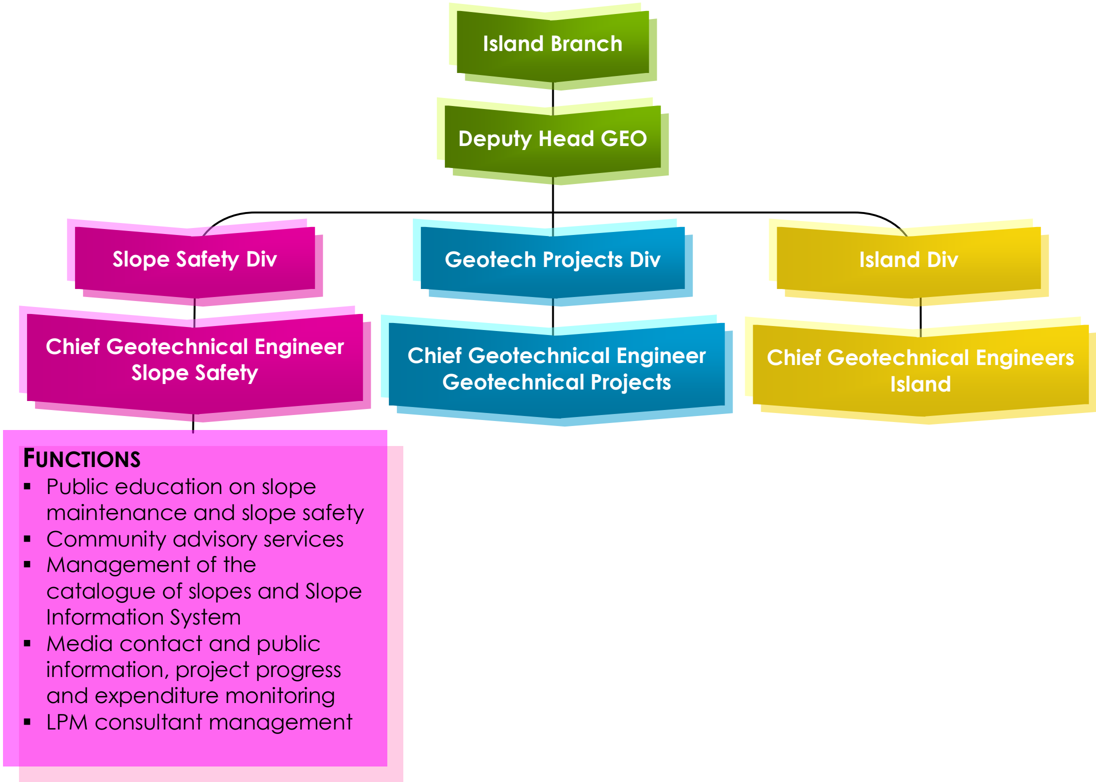

Figure 7.5: GEO Organizational Structure

The public awareness function at GEO was established in 1994, almost twenty years after the set up of GEO. Until then much of the focus on GEO was on engineering slope works. However, a 1993 landslide triggered public and political furor over the way the incident was handled, and in the aftermath of the incident, GEO engaged in an overhaul of its public communication strategy and procedures.

Figure 7.6: A slide from GEO's "Crisis Management Communication" presentation

The subsequent series of measures undertaken resulted in a culture change within the entire organization, from that of an internally-driven communication model ("need-to-know" basis) to one that is externally-driven (answerable to external questioning) as shown in the table below.

Table 7.1: Paradigm shift at GEO after the Kwan Lun Lau Landslide

Before the 1993 Kwan Lun Lau Landslide (early 1990s and before)	Driving forces for change (mid-1990s)
▪ Only high-ranking officers allowed to talk to the media ▪ Complicated and lengthy procedure to answer a media enquiry ▪ Overcautious and nervous about dealing with the media ▪ Hostile to the media	▪ Increasing democracy ▪ More critical media and political environment ▪ Public expectation for safer slopes in HK ▪ Public support is essential to slope safety functions ▪ Media provides an effective means for the agency to communicate with the public, Legislative Council members, and the Central Government

The scope of the public awareness and education function was also expanded to include real-time public communication with the media, the general public, and council members during the course of and after a slope disaster.

In addition to the landslip warnings and advisories to the public on avoiding slope areas after heavy rainfall, GEO provides is given continuous educational exposure through various methods stated in Section 7.3.1, "Evaluation of Methods".

It should be noted that adoption of the GEO structure and system must be tempered with an understanding of the differences between the systems in the two countries.

Table 7.2: Differences between Hong Kong and Malaysia

Hong Kong	Malaysia
Population homogeneous	Multicultural and multiracial backgrounds
GEO infrastructure already in place (1977) when PAE set up (1997)	Not yet set up
Land coverage by private slope owners small/focused	Large land coverage
Type of development offsets costs of maintenance	Typical type of development may not offset costs in maintenance (for example, mass housing)

Australia

Emergency Management Australia (EMA) provides support to various government agencies in developing measures against hazards. While the states or territories produce localized material, such as brochures on flooding in Katherine, storm surge in Cairns, fires in country Victoria or Western Australia, the EMA material provides generic Australia-wide advice on these hazards.

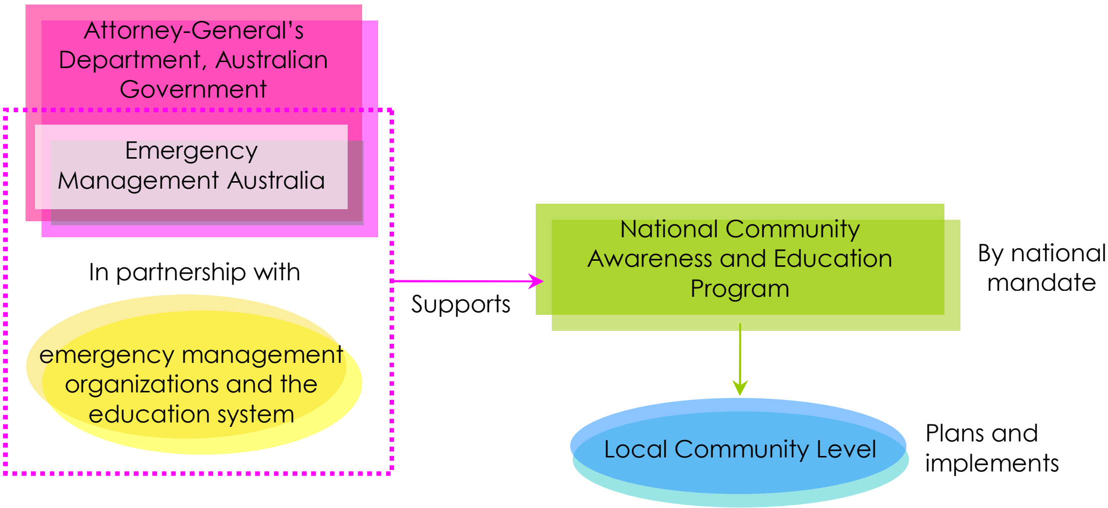

Figure 7.7: Public communication structure in Australia

7.4.2 Evaluation of Methods

There is a plethora of methods that can be used to target audiences, and while there are no hard and fast rules that dictate which one is better, there are some tips and guidelines regarding suitability of each method to a particular target audience. An oft-repeated advice to public awareness programme planners for reaching audiences is to use methods that are a normal part of the target audience's communication channel. For example, posting a website to an audience that do not have Internet access would not be an effective method.

Research shows that the best programmes utilize a mix of various methods, rather than relying on a single approach. To come up with the right mix of methods for each target audience, it is necessary to create audience profiles and conduct surveys.

For a basic guideline and information on the functions of each method, a direct extraction from Australia's Emergency Management Association is presented below. It is important to bear in mind that these experiences are endemic to an Australian context only and that validation of these methods must be conducted before applying them in a Malaysian populace.

Source: Australia Emergency Management Association

Print and Electronic Publications

Brochures, booklets, and posters	The important consideration with brochures is not in their production, but in the method of distribution. Sources recommend against mass, untargeted distribution and point to distribution at key points, such as shows and event and shopping centers.
Pluses	Production—especially for large print runs—can be inexpensive. Provide versatility in that brochures can be used for many audiences and uses.
Minuses	Requires planning in distribution. Material can become obsolete after a time.
International Experience and Examples	An American Red Cross study provides guidelines on the optimal number of publications that should be distributed at any one time. It showed that people tended to keep brochures if they were given fewer than three pieces of material. When given four or more pieces, only 12 percent of recipients kept them, in contrast to 44 percent of recipients who kept two or three pieces.

Flyers	Overall, flyers are one of the cheapest forms of hand-outs. Usually they come in one color, on a single sheet of paper and may be photocopied. It has been noted that flyers are usually more effective for publicizing events and announcing competitions rather than providing information for long-term use.
Pluses	Production is cheap.
Minuses	The design must be attractive and have strong design impact, or else the pieces will be thrown aside and ignored.

Letterboxing and mailouts	Another cost-effective way to reach audiences is placing materials in the mailbox. Although they may run the chance of being discarded as 'junk mail,' personalized addressing of recipients may be effective.
Pluses	Allows for localized information.
Minuses	Large-scale distribution may be challenging as well as costly due to postage and handling charges. Adequate resources to build up and maintain mailing lists must also be considered.

Inserts in newsletters and newspapers	Also considered effective is the use of inserts in local newspapers, newsletters, and shoppers' catalogues. There may be an insert fee charged by the newspaper, although it may be cheaper than

	postage and handling costs.
Pluses	Established distribution network. Credibility of the host publication.
Minuses	An insert competes directly with other inserts in the same publication.
International Experience and Examples	Important community information can be printed on inserts in other mailouts, such as rate notices. This method is often used by local councils.

Advertising	To reach a large number of people, advertising is one of the best media channels to employ. Spread your advertising dollars by looking for sponsorship and subsidies.
Pluses	Guarantees the delivery of the message.
Minuses	High cost of advertising.

Internet, CDs, blogs, and multimedia technology	Some of the online resources for disseminating community information are websites, RSS feeds, blogs, and other digital media.
Pluses	Establishing and maintaing a website requires some expertise and effort.
Minuses	Difficult to assess whether the website is being accessed.
International Experience	Internet: Not only are prevention and preparedness information accessible on the internet, many emergency management organizations are making efforts to provide real-time information available as well. CDs: Numerous educational CDs provide education on disaster preparedness through interactive means. Computer: Computer simulation can be a communicator of past or predicted disaster and is especially compelling in showing "what-if" scenarios. Simulations enable data from models to be viewed and demonstrated for practical applications such as viewing the benefits of implementing mitigation strategies. Television: Televised animation of the Thredbo landslide disaster in 1997 and coverage of the Papua New Guinea tsunami in July 1988 were excellent examples of the media's ability to portray graphically the effects of hazards on communities.

Give-Aways

Give-Aways	Practical promotional products such as fridge magnets, caps, T-shirts, coffee cups, and stickers provide visible reminders of messages, contact information, and other emergency-related information. Competitions and contests with in-kind sponsored prizes can be effective as long as they are well-targeted, relevant to the target

	audience, and heavily promoted.
Pluses	The items have a long life-span and provide prominent identity.
Minuses	Give-aways are costly to produce.
International Experience and Examples	The Australian Maritime Safety Authority (AMSA) developed a scheme to provide Torres Strait Islanders with a small-boat survival kit that has become the focus of an awareness campaign about safety at sea. Many islanders who island-hopped in small aluminium dinghies were known to run out of fuel. Their small boats carried no locating devices, and AMSA often faced the task of finding a small boat in a large expanse of sea. The AMSA kits, containing an EPIRB beacon, signals, rations, and a V-sheet (a groundsheet with a black V on an orange background to be used as a distress signal), are available on loan from local police stations.

Face-to-Face Communication

Doorknocking and Street Meetings	Of all the communication methods to reach people, face-to-face is the most effective. Going door-to-door to talk about preparedness information and hazard awareness gets the undivided attention of residents and makes them more receptive to messages. The venue can be in people's homes, on their streets, or in a common area within their subdivision.
Pluses	Allows you to provide a personalized message.
Minuses	Resource-intensive; requires a large number of people.
International Experience	It was found that it takes much time and many volunteers to be reach households within a community. For example, it may take a team of 10 a whole day to knock on 600 doors and talk to around 300 households. One way to alleviate the resource problem is to be selective, such as choosing households with definite hazard risks or ask household members to spread the word to neighbors.

Formal Community Meetings	A less resource-intensive approach would be to gather community members at a common venue. Keep in mind four tips when moderating such meetings: make sure that the meeting is based on community needs and preferences, promote the meeting, make the meeting acive, and keep it interactive.
Pluses	Provides the opportunity to talk directly to people, to explain the situation, and to answer questions.
Minuses	Unless the meeting is well-publicized, it may not attract enough people to make the meeting effective.
International Experience and Examples	The South Australian Fire Service has used a community group approach to community awareness, inviting 40 community representatives to informal meetings to discuss disaster preparedness. Those representatives take the information to their

	respective constituencies. An American Red Cross study found that best results in terms of behaviour change came from matching images and messages in public presentations.

Shopping center displays	Shopping centers are frequented by community members and thus make it an ideal venue for reaching out to the public. However, bear in mind that shopping centers are not frequented by all the segments of the public.
Pluses	Provides face-to-face interaction with the community.
Minuses	The display must be eye-catching enough that it encourages passers-by to stop, ask questions, and listen to explanations. Otherwise people will ignore the display, and the opportunity to liaise with the community will be lost.
International Experience and Examples	In Queensland, Australia, a storm surge awareness campaign used a combination of tactics featuring a pelican, Stormin' Norman. The campaign targeted the 'influencers' in families, the mothers, carers, and children, as better able to retain information and take action at home. A display was taken to shopping centers with a videotape featuring Stormin' Norman, brochures, and stickers and balloons for kids, and emergency service representatives available to talk with the community face-to-face. The information was based on scientific research by the Bureau of Meteorology and others in storm surges.

Displays at trade shows, exhibitions	Like shopping center displays, getting the attention of passers-by is paramount. It helps to heed several tips, such as making sure that the visual display is arresting enough to attract attention and being clear on who you are targeting so that messages will be directed accordingly, as such as recruitment of volunteers or information to heads of households).
Pluses	Provides face-to-face interaction with the community.
Minuses	Care must be taken to confirm that the objective and nature of the trade show or exhibition matches your objectives, and that the visual displays be attraction-grabbing and attractive.
International Experience	The Northern Territory Emergency Service (NTES) locks into the country show circuit and mounts displays at Alice Springs, Darwin, and Katherine. Localized material on floods and cyclones is handed out with EMA Action Guides. The NTES also uses the visits to deliver information material to police stations in the area, calling also on local media with copies of cyclone and flood awareness material which the media then promote.

Special Events

Special Events	Anniversaries of key disasters that have affected the community serve as reminders and renew the awareness level of potential dsasters. This is particularly effective for oft-repeating disasters, such as floods. International and national awareness events such as World Environment Day are also a good platform to raise awarness of your cause. Such participation localizes the event to a level that the community can relate to, and more importantly, act on.
Pluses	Effective reminders
Minuses	Promotion and build-up must be done to avoid poor turnout
International Experience	Many States and Territories concentrate awareness-raising activities during a particular week, such as Fire Awareness Week and SES Week.

Active Community Participation

Active Community Participation	Community participation is the instrument for residents and community members to have a direct hand in public policy and plan formulation. This activity brings community involvement a notch higher from mere awareness to affecting changes.
Pluses	Community input into buidling disaster resilience
Minuses	Calls for trained facilitators; education on the mechanism of public participation; identification of organized, well-informed, non-partisan community leaders and opinion makers
International Experience	Volunteer groups: Community Fireguard is made up of small groups, existing resident groups, small groups of neighbors in high fire-threat areas, and conservation groups such as Landcare that are interested in reducing fire threat and effects. Working together, with the support of the CFA and facilitators, the groups develop simple and inexpensive strategies, effective in saving lives and homes. The programme is based on the exchange of information on fire-preparedness—everything from evacuation and ember-proofing a house, to what to do with family pets. Murals: Disaster awareness murals use public space, provide large eye-catching displays and an outlet for local artists and schools, and may help prevent vandalism and graffiti. Theaters: Try community theatre groups and low-budget videos using local talent to carry awareness messages. Those involved in writing the scripts and acting in the production are likely to be much better informed about the hazard than before they started. They can then spread the word to others. Presentations can often be made at schools assemblies, clubs, parents and teachers, and other community meetings to save on venue hire and promotion costs. DIY Risk Assessment: Develop school-based or organization-based risk assessments of your local area. This could involve a historical

	assessment based on newspaper searches and interviews with long-time residents and an examination of the current level of preparedness of both the emergency services and the community itself. A public assessment of this nature can increase understanding of those involved in the process, encourages ownership of the results and may provide maximum exposure to other residents and to the media.

Hong Kong

Similarly, Hong Kong provides the following methods for generating awareness and disseminating educational information.

Table 7.3: GEO's public awareness toolbox

	Tools Used to Reach Out to the Public
✓	Leaflets, booklets, books
✓	Posters
✓	Information Notes
✓	Roving exhibitions
✓	Community Advisory Services
✓	Radio and TV APIs
✓	Video production
✓	Give-aways
✓	Roving exhibitions and school talks
✓	Community Advisory Services
✓	Publication of book on landslides
✓	Major exhitions
✓	Jointcommunity service with Hong Kong Red Cross
✓	Reminders to morning walkers on Landslip Warning signals
✓	Reminders to owners about illegal hillside cultivation
✓	Workshops and popular science lectures at science museums
✓	Seminars on natural disaster reduction
✓	Contests, such as slogan and bookmark design
✓	Commemorative stamps

The selection of methods for audiences varies from culture to culture. What may work for the citizens in one country may not be in another. Therefore, a thorough and understanding of the preferences, communication needs, and constraints of each target group is essential to the success of the programme.

Figure 7.8: Collection of GEO public awareness material

7.4.3 Programmes and Social Psychology

One of the ways to understanding the public is to engage in social research, or talk to social scientists who may lend expertise and insight into the local population. It is worth noting that social science research into effective methods for educating the public on hazards exists and should be referenced when assessing programmes and for crafting and delivering messages. However, it is also known that although the methods are well-accepted by the target audience, the public does not always necessarily heed them.

7.4.4 Method Selection by Target Audience

A listing of methods for public awareness and warnings compiled by the University of Wisconsin is based on those used in connection with social programmes around the world, such as agricultural improvement, adult education, family planning, and nutrition. These basic method guidelines, which although proven, will need to be localized among the countries depending on their specific needs.

Table 7.4: General methods for target audience groups

Method	Recommended for
Mass media (press, cinema, radio, television)	Present generation of adults
Folk or alternative media	Other sections of the population
School curricula	Next generation
Public works programmes	Fatalistic groups
Seminars and training in disaster prevention and preparedness and public information dissemination	Government officials
Government advisory services	General public
Participation in monitoring and warning activities	Communities
Civil defense programmes, national programmes (develop to be first responders)	Young generations

Whatever methods are used, the key success factors of public awareness programmes are enumerated in literature from the University of Wisconsin's Disaster Management Center:

- Long-term rather than short-term
- Have built-in evaluation for effectiveness in the mid-term
- Incorporate the educational infrastructure, from primary schools to university level
- Aim at both the general public and the special publics (including official levels)
- The programme should be national, regional or local in character to increase the motivation of those taking part in the programme, as well their knowledge about the hazards
- It should be an extension of the public information programme
- It should take advantage of normal conditions or life, normal modes of behavior, and normal sources of information in the preliminary stages

7.4.5 Rural vs. Urban Target Audiences

Many of the methods discussed thus far have been prepared for urban audiences. Comparable approaches have to be designed for rural audiences.
According the University of Wisconsin, these rural audiences may prefer:

- Multi-colored leaflets, pamphlets, and brochures with realistic and familiar illustrations
- Generously illustrated formats with adequate accompanying textual explanations
- Posters and flipcharts on white, glossy paper
- Texts written in the dialect of the district that suggest or give straightforward solutions to village problems
- Up-to-date information on innovations, detailing the conditions under which these are adaptable
- Mutually supportive texts and illustrations
- Step-by-step accounts of how to use any innovations

In general, the rural audiences place greater value on personal channels, while urban audiences would seem to prefer to the mass media—radio, television, newspaper, and film.

Again, these approaches need to be verified with rural audiences in Malaysia to determine whether they are indeed appropriate for adoption in this society.

7.4.6 Cost and Reach of Methods

The selection of methods will be largely determined by budgetary considerations. Dr. Jakki Mohr, an associate professor of marketing at the University of Montana-Missoula formulates a generic advertising and promotion pyramid that positions advertising and promotion tools based on two dimensions:

- The degree of coverage, or reach, of the target audience
- Cost efficiency, calculated as cost per thousand (CPM)

CPM = $\underline{\$ \text{ Cost of the advertising and promotion tool (e.g., ad in a journal)}}$ x 1,000
Number of people the tool reaches

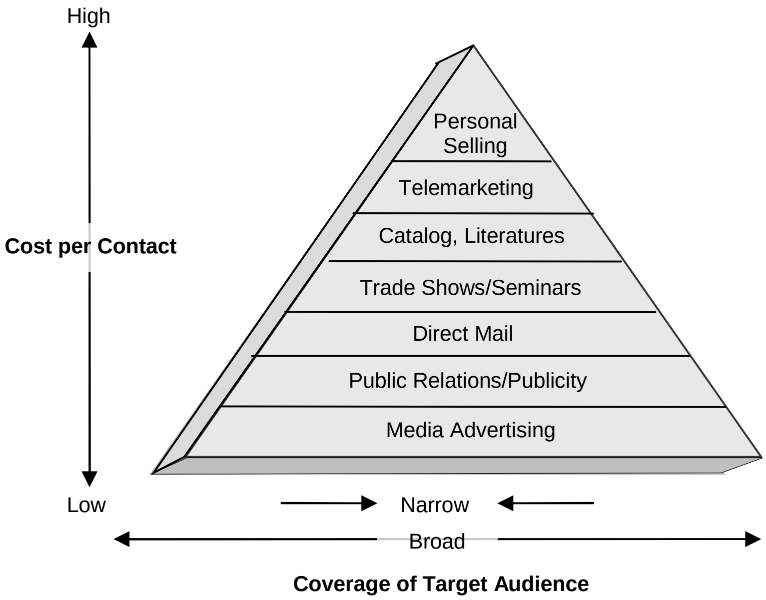

Figure 7.9: Advertising and promotion pyramid

This CPM is an aid in making decisions about method and target group selection.

Another tool for determining the optimal way of exposing a message to the public is the following formula:

Reach x Frequency x Population = Gross Impressions or Exposures to the Message

According to EMAP's definition, "reach" is the percent of the target population in a geographically defined are exposed at least once to the message during a specific time frame, while "frequency" is the number of times a message has been broadcast to a target audience.

Public education efforts should strive to reach an optimal number of gross impressions when disseminating disaster material to the public, which is achieved through a combination of both reach and frequency. Using existing data from local media markets as well as cost estimates for making public service announcements for each medium will help programmes select the approach to deliver the message.

7.4.7 Shortfalls in the Current Methods

As mentioned earlier, knowledge does not necessarily translate into action, even with programmes that have been deemed effective, largely because of the non-recurring nature of landslides in many areas.
Many public education efforts to change warning response need considerable improvement, judging by the fact that some proportion of the population usually fails to take appropriate action despite well-understood warnings.

7.4.8 Socio-Economics and Media Coverage

In a study conducted by a geotechnical science researcher under the tutelage of Professor Andrew Malone, Head of the Geoscience Department at the University of Hong Kong, it was discovered that the amount of media coverage of landslides in Malaysia corresponded directly in proportion to the socio-economic and geographic location of the landslide events (Abdul Rasid 2006). In other words, some events received less media coverage than others, even though the impact of the landslide was quite sizeable. No explanations were given for this phenomenon. However, it will have ramifications in future programme design in that awareness and education activities must be focused in these areas to compensate for the lack of adequate coverage.

7.4.9 Development of Messages

In developing messages to give to the public, the University of Wisconsin provides seven principles of communication that must be heeded:

- Credibility
  the recipient must have confidence in the source, and this may involve building a climate of belief between the sender and the receiver.
- Context
  the communication programme must form part of the normal environment of the audience. Context must confirm, not contradict, the message.
- Clarity
  a message must be in simple terms, and the further it must travel, the simpler it should be.

- Continuity and Consistency
  messages should be repeated and they should be consistent with one another.
- Content
  the message must have meaning for the receivers. It must be compatible with their value system and must be relevant to their problems.
- Channels
  established channels of communication should be utilized, particularly channels that are used and respected by the audience.
- Capability
  the message must take into account such factors as the audience's availability, habit, degree of literacy, and knowledge of the world.

The EMAP Council also has its own acronym for effective communication—STARCC, which stands for simply, timely, accurate, relevant, credible, and consistent. Whichever the acronym used, the message is the same: to keep information to the public as simple as possible, in a consistent manner, by a credible source.

The importance of adhering to these principles cannot be understated. In a case study written by JICA under the BBEC Programmeme for raising awareness on the fauna and flora in Sabah, a Japanese education facilitator (an evolutionist) relates how he came into conflict with a fellow Malay trainer (a believer of creationism) over his message on human evolution and the similarities between man and ape. When the Japanese researcher commented on the similarities between the hand of the ape and that of man, his colleague was quick to dismiss this notion. Although this issue was eventually settled amicably, this underscores the importance of understanding the religious belief and value system of the recipient audience.

7.4.10 Messages

The American Red Cross provides guidelines for developing messages. They are categorized as:

- Awareness messages
- Action messages
    - Be Prepared for a Landslide: Protect Yourself

- What to Do during Severe Storms, which Can Trigger Landslides
- What to Do If You Suspect Imminent Landslide Danger
- What to Do During a Landslide
- What to Do After a Landslide
- Media and Community Ideas
- Facts and Fiction

These messages are developed for a U.S. audience, but can be localized for application in Malaysia.

7.4.11 Mitigation And Preparedness Information

While proper message development is important, it is also vital to confirm that awareness messages are synchronized with the overall strategy and capability of the implementing agency. For example, in Hong Kong, GEO slope strategy was divided into phases with specific goals:

Phase I strategy: Control over hillside development
Phase II strategy: Slope safety
Phases III strategy: Beautification

At each phase, all activities—including public awareness—adhered to the central strategy being promoted at the time. This ensured consistency among all the activities of the agency across the board.

Another consideration is adequate resources. Adequate capability and capacity is paramount to ensure that the messages can be backed up by the implementing agency. For example, if one of the messages is to encourage residents to report signs of landslides, there must a call center set up within the agency to handle these calls, validate the call, and have agency personnel investigate the site in question. This means that the agency must have a wide network of personnel to investigate the site being reported. Failure of the agency to act upon public reports can have negative effects. If a member of the public takes the initiative to report but the promise made by the agency to follow up is not carried out, subsequent messages of safety and slope owner responsibility will be viewed with cynicism. This highlights the importance of the agency to manage the course of action being promoted in the message and to ensure that adequate manpower and training is allocated.

7.4.12 Public Information

Just as important as the mitigation and preparedness, if not more, is the capability of public to understanding warnings of impending disasters. Although warnings fall under the domain of emergency management, there are communication guidelines that ensure the effectiveness of the warnings. From the point of view of the public, the warning will be most effective it is:

- Issued by a person or organization in whom public confidence is placed
- As specific as practicable concerning the magnitude of the event, the place at which it is expected, and the time when it will occur
- Susceptible to independent confirmation

A study conducted in the United States recorded that generally, persons of high and low socio-economic status differed in their perceptions of preferred warning sources. Higher status citizens preferred government sources, while persons of lower socio-economic status preferred information preferred information from the Red Cross.

7.4.13 Messenger

This point ties in with the issue of credibility and authority. According to Wisconsin, technical personnel such as geotechnical engineers or geologists must have the ability to work with non-scientists and government officials and representatives of disaster relief organization. It is thought that by working together with stakeholders and disaster management partners, engineers would better understand the respective partners' information needs and wants, as well as limitations of various approaches.

The Wisconsin research encourages engineers to build a rapport with residents of the areas concerned, not only with community leaders, but with the populace as a whole. A better understanding of their feelings, reactions and behavior under stress would provide insight into how to gain their confidence and ease the public's anxiety in times of crisis.

The role of the engineer as a reassuring presence in critical moments cannot be overstated. It has been stated that it is the unknown or not-understood dangers that terrifies. By explaining the situation on hand or communicating the dangers in a language that the layman public can understand, the engineer can avert the risk of panic. The sentiment that the mere presence of a geotechnical engineer at the site of a landslide can inspire reassurance has been echoed in interviews with numerous emergency first responders.

7.4.14 Sustaining Awareness

In discussions with Hong Kong's GEO, it was commented that during times when there are no landslides, messages to the public tended to focus on how dangerous slopes can be. Conversely, in times during and after landslides, the messages provided reassurances that the slopes were safe.
This polar switching of messages shows how important it is to adjust the tone of the messages by using the public's sentiments as a barometer. Methods also change according to the frequency of landslide incidents and the public's level of interest. After a prolonged period of no landslides and the public's confidence in Hong Kong's early warning system, the public's awareness of landslides had begun to decline.

In an attempt to sustain awareness, GEO published a glossy coffee table book on the slopes of Hong Kong. The lesson learned was that different methods and messages are used in creating and sustaining awareness.

7.4.15 Development of Educational Material

Before developing education material, care must be taken to target the audience groups

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7.4.16 Stakeholders

Planners for all the public awareness and education systems that were studied have segmented the population and identified specially targeted groups. In Sabah under the BBEC Programmeme, the target audiences are teachers, journalists, policy makers, developers, and non-environmental NGOs. In Hong Kong, they are students, police officers, government departments, children, and morning walkers. For Malaysia, the target audience groups are:

- Government Agencies
- Commercial
- Non-governmental Agencies
- Special Interest Groups
- Media
- Academia
- General Public

Another group consisting of Emergency First Responders (i.e., BOMBA, police, civil defense, ambulance and emergency aid, public health workers, and others having responsibilities in disaster management) should also receive education on the nature of slope failures and landslides. Further information on education for this group will be found in the Sectoral Report for "Training."

Educational programmes vary in content and format depending on the target audience. For example, material for schools tends to be more formal and didactic in approach while those for the general public veer towards mass media and event management. Examples of such programmes are described below.

7.4.17 Academic Target Groups

Hong Kong - Primary and secondary school children

In conjunction with the Chinese University, GEO has developed a comprehensive Education Kit for secondary schoolchildren throughout Hong Kong. The objective is to instill knowledge about slopes and the phenomenon of landslides so that slope safety will be built in with the new generation of productive citizens entering society.

The Kits are supplemental to the national curriculum, and every secondary school in Hong Kong has at least one set of the Kit. The Kit is introduced in the classroom during the Geography lessons. For example, Chapter 2 of the Secondary Form 2 geography book introduces the topic of landslides, and the Kit is used during this time to supplement the textbook. To ensure that the Kits conformed to national curriculum guidelines, it was developed under the auspices of the Education Authority.

There were no pilot programmes to introduce the Kits into the school system. Instead, the Kits were promoted through public awareness, such as at school assemblies and talks.

The Kits, which are packaged in an attractive box with handles has slots for textbooks, worksheets, and information sets for Levels 2, 4, and 6 for the secondary level students. There is also a slot for CDs and give-aways.

The content for the different levels varies, from articles to short essays on landslide accidents (Ching Cheung Road landslide, Castle Peak debris flow). At the end of the Secondary 4 level textbook, there are landslide preventive measures and some worksheets.

For the Secondary 6 kit, there is an article on the Shum Wan Road landslide as well as the site plan. At the reading, there is a comparison of the location before and after the landslide). All the books contain worksheets.

The Kit is currently scheduled for updating and for tighter coupling to GEO's Hong Kong Slope Safety website.

Sabah

Curriculum prepared under the BBEC Programme by JICA/Sabah State Government takes a different approach. Course materials are prepared as supplements to the National Curriculum, and are introduced into the classroom at the initiative of the teachers or headmasters of the schools.

There are exercise books containing problems to be solved in various subjects, such as mathematics. Math questions are couched in an environmental theme, such that the subject of the problem could be an endangered animal or plant. It is a more indirect approach than in Hong Kong, where the environmental issues are introduced in the context of problem-solving.

The course material, which took two years to develop, was created by the BBEC education specialists and the Ministry of Education. Having started with a pilot programme of 22 schools, the BBEC Education Programme is now introduced in all the schools throughout Sabah.

Australia

Australian sources on this subject state that emergencies and disasters are popular topics with students and can be readily adapted to geography, science, health and physical education, math and English. Target schools can encourage long-term shifts in knowledge, attitudes, and behavior in relation to hazards and can transfer over time to the adult population. Emergency management content can be used to teach generic life-long skills such as risk management, decision-making, and problem solving.

Public awareness planners are advised to talk to schools about how students can be encouraged to think about preparedness for emergencies. It could be a classroom talk, perhaps an emergency response personnel talking about disaster experience, a display, or a flyer or brochure distributed to the children and their parents. There is a demand for school visits by emergency management organizations as long as the information imparted and the arranged visit fit the curriculum.

The school information network can also be used to distribute messages to the community. Through classroom assignment and newsletters, students take home the information to their families.

While targeting schools can be an effective way to disseminate information to parents and children in a receptive learning environment and may promote long-term risk reduction, such works takes time, effort and acceptance of the school community.

Hong Kong - University students

In an interview with Prof. Andrew Malone, Department of Earth Sciences at the University of Hong Kong, civil engineering students are required to take a course called "Professional Practice: Risk Management". The course introduces engineers to the risk, hazard, and social vulnerability aspects of development, not only in geotechnical science but in all civil engineering disciplines. The aim of the course is to make students aware of the risk and social factors involved in civil engineering works.

7.4.18 Non-Academic Target Audience Groups

Unlike the academia target group, educational material for the other target audience groups does not take the approach of formal education. Rather, the education programmes are presented using methods, or tactics, mentioned in the previous section, such as face-to-face advisories, seminars, exhibitions, booklets, CDs, and websites. As mentioned earlier, material from schools can be localized to the communities for lifelong education such as preparedness, first aid, and other emergency-related skills.

For these audiences, the instructional objective of the education programmes is aimed at *behavior modification*, rather than *changing the mindset*, as the latter is difficult and takes a long time to achieve (BBEC, 1998). The behavior modification approach enabled social planners to achieve the desired results to save lives and reduce loss.

Education for these groups focused on delivering the two essential areas needed for resilience:

- providing knowledge (teaching the impact, effects, and consequences of landslides)
- providing how-to's on preparedness and types of warning (public information), survival (what to do during), and on recovering and resuming livelihood (after landslides)

Japan

Literature on public awareness and education programmes in Japan were sourced from the Infrastructure Development Institute at the Ministry of Land, Infrastructure and Transport (MLIT). Much of the information gathered from Japan thus far concerned public capacity building in the warning and evacuation system against sediment disasters. According to MLIT, slope-related disasters are termed as "sediment disasters," under which fall the categories of landslide, slope failures, and debris flows.

MLIT places much emphasis on the public's participation in the monitoring of sediment disasters, and provides educational material on the signs or "precursors" of such disasters. In particular, capacity building in monitoring for signs of debris flows is highlighted, and education is provided on observation and reporting procedures.

Table 7.5: Precursors of sediment disasters

Slope failure	Debris flow	Landslide
▪ Water from a precipice or a slope becomes muddy ▪ Cracks appear on a precipice or a slope ▪ Small stones fall ▪ A sound is heard from a precipice or a slope	▪ A rumbling sound of the mountain is heard ▪ The water level in the river lowers, though rain is continuing ▪ The river water becomes muddy or includes driftwood	▪ Cracks appear on the ground ▪ Water in a well or a valley becomes muddy ▪ Water gushes out from a precipice or a slope

In spite of the emphasis on visual observation of slopes for monitoring purposes, it has also been stated that sediment disasters are by nature difficult to predict, and the lead time for warning and subsequent preparation can be has very short. Thus, immediate evacuation activities are considered important measures in disaster resilience, as they are the last resort in escaping disaster. To this end, MLIT encourages the public and the local authorities prepare:

- Evacuation maps and procedures
- Evacuation facilities
- Hazard maps
- General education to the public on disaster mitigation and response

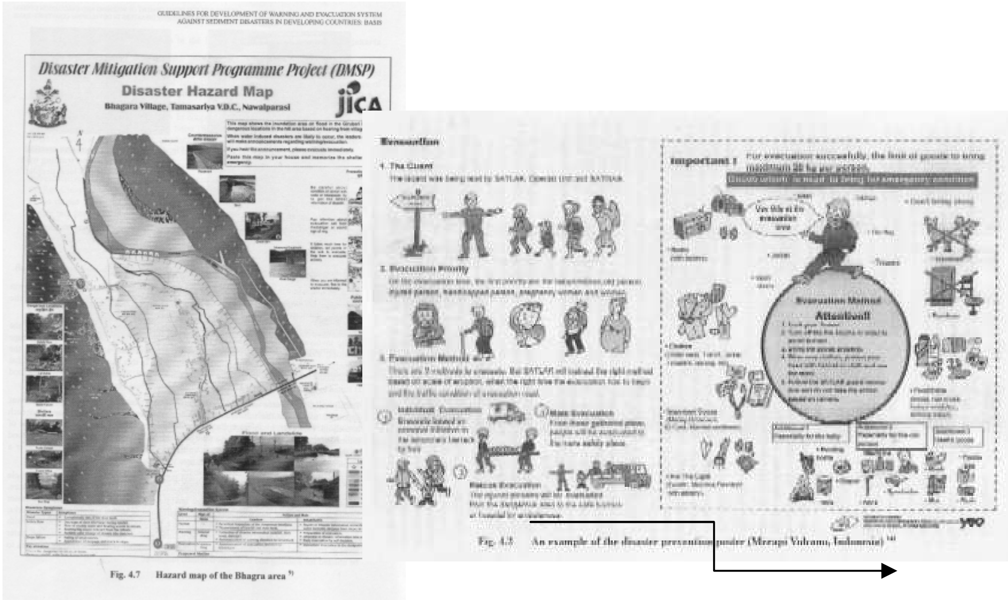


Figure 7.10: MLIT's Hazard Map and Evacuation Procedures Poster for the Public

It is interesting to note that MLIT encourages the public dissemination of hazard maps to the general public. Reactions among Malaysian government agencies and organizations have been mixed on this issue, with proponents saying that residents and homeowners have a right to know about hazards in their areas, while others are more cautious over raising the ire of homeowners whose property value may depreciate due to publicized hazard demarcation.

Some of the methods recommended by MLIT are listed as follows:

- Disaster mitigation knowledge must be distributed and disaster mitigation awareness must be improved through school education and community activities
- Have the public understand the danger of sediment disasters through a variety of events such as lectures and fairs, and such information distributed through manual, maps, posters, and videos.
- Designate a Disaster Mitigation Day or Disaster Mitigation Week and carry out a large-scale disaster response/evacuation training approximately once a year

with the cooperation of the federal, prefectural, and municipal governments as well as disaster management organizations.

7.5 Findings in Local Experience

In order to reach a level at par with countries having an extensive public awareness and education programme on landslide risk reduction, it is necessary to get a bearing on what is the current status of public awareness and education in Malaysia. This section discusses the local programs currently being conducted, highlights what are the local needs and issues, and presents a SWOT analysis from which the results will guide the development of strategies in the final section of this report.

A caveat must be mentioned here that the subjects interviewed and the areas studied were confined largely within the Klang Valley. Hence the findings are heavily slanted to urban target groups in middle- to high middle-income groups. Results from future demographic and socio-economic studies in other parts of the country may come to bear on the methods proposed in this report.

7.5.1 Existing Programs

At an R&D Workshop conducted by IKRAM Sdn. Bhd. with research universities, Prof. Madya Dr. Felix Tongkul of Universiti Malaysia Sabah pointed out that projects for mitigation are ad-hoc, and that practitioners address problems of slope failure only once they occur. He also cited that not enough attention is paid to preventive measures. This is a theme reiterated not only in Malaysia, but elsewhere in the world: New Zealand's National Institute of Water and Atmospheric Research (NIWA) also once stated that flood mitigation efforts did not start in earnest until a series of devastating flood events in the 1950s.

Social Worker Sharima Ruwaina Abbas of the Malaysian Association of Social Workers noted that a considerable number of social and trauma recovery services offered to the public is taken up by non-governmental organizations. This highlights the Government's current emphasis on providing physical and tangible aspects of recovery such as housing, financial assistance, and medical care, while the provision of psychosocial, intangible services such as social and mental heath recovery is provided by relief organizations such as Mercy Malaysia, Force of Nature, and the Malaysian Association of Social Workers.

While response and recovery are vital to the road to community recovery, emphasis on pre-disaster activities such as public awareness and education for preparedness and mitigation are necessary for building community resilience.

However, in light of the increasing frequency and magnitude of disasters, chronic failure incidents, and a growing safety- and environmental-conscious populace, awareness and education campaigns in various sectors abound. Listed below are some of the current programs and campaigns in the areas of public safety, health, and disaster recovery.

Table 7.6: Examples of public awareness and education programs in Malaysia

Agency	Mission	Comment	Programs
JKJR (Road Safety Department)	To reduce loss of lives through road safety	This is one of the more aggressive campaigns UPM: Road Safety Research Centre provides input into programs Pilot programs in Pasir Mas, Kelantan	Print ad TV APIs/Radio School programs Web messages Community programs Private sector partnerships Multi-agency operations, such as Ops Sikap enforcement operation
NRE (Ministry of Natural Resources and Environment)	To stop littering		Print ad
DID (Department of Irrigation and Drainage)	To increase appreciation of the environment and reduce river pollution	Pilot programs for teachers in Sungai Tok Tukang, Langkawi	Train the teachers (on how to use bio-indicator techniques to assess water quality Outreach program to hold individuals accountable for river pollution Works with Global Environment Centre (GEC) in the River Care Programme
Jabatan Kesihatan Malaysia	To provide health tips during floods		TV ad on health practices during floods
Mercy Malaysia	To provide relief and prevention assistance for flood		
Malaysian Meteorology	To create awareness, provide education in	Study conducted by Universiti Putra Malaysia	Pilot program conducted in three villages in Langkawi to

Department	evacuation for tsunami		train residents on evacuation drills
Malaysia Nature Society, The Body Shop Malaysia, and Grey Worldwide Sdn. Bhd.	To highlight the imminent effects of global warming	The Body Shop ran a campaign on acid rain in 1992/93. Working on other projects such as the preservations of rainforests and coastal reefs.	Produced five picture postcards

7.5.2 Methods Used

As shown in the "Programs" column of the previous table, the methods used—such as print and TV/radio advertisements, posters, community programs, and partnerships with private industry and non-governmental organizations—are standard awareness and education approaches used in similar programs around the world.
In addition, community programs in rural communities where direct, face-to-face, hands-on involvement are also mentioned as producing effective results. Practitioners from the National Security Council and the Social Workers Association of Malaysia reiterate the importance of using hands-on methods that attract the rural communities.

Thus, local data and inputs confirm the secondary source findings highlighted in the study literature review: **in general the rural audiences place greater value on personal channels, while urban audiences would seem to prefer the mass media—radio, television, newspaper, and film.**

Rural Audiences

The Malaysian Association of Social Workers provides several suggestions on presenting educational programs to the rural community. Based on their experiences, one of the most effective methods in approaching the orang asli, or the indigenous people in Malaysia, is face-to-face discussion with the community leader such as a tok batin, rather than approaching the community members themselves.

The Malaysian Association of Social Workers provides several suggestions on presenting educational programs to the rural community. Based on their experiences, one of the most effective methods in approaching the *orang asli*, or the indigenous people in

Malaysia, is face-to-face discussion with the community leader such as a tok batin, rather than approaching the community members themselves.

Social worker Sharima Ruwaini Abbas also recommends that workshops are more effective than seminars, where participants are encouraged to get involved. For greater bandwidth with limited human resources capacity, the practice of training the trainers is a viable method.

For both the rural audiences and for schoolchildren, printed material with colorful visuals—as opposed to heavily text material—are preferred.

School Audiences

In 2001, the Ministry of Education, under the auspices of Unicef and in partnership with Mercy Malaysia, introduced a School Safety Manual program which created awareness among the schoolchildren in several states on a number of disasters that afflicts Malaysia. The School Safety program consists of three separate elements: the manuals created by the School Safety Committee for preparedness and action measures before, during and after disasters; a school watching exercise where students and faculty are encouraged to map an inventory of hazards and risks around the school for student-initiated mitigation projects; and a teachers' training program where teachers train abroad to learn about disaster risk reduction and come back to create safety kits as well as train teachers in other schools. As in the cases with Hong Kong and Sabah, the safety material is introduced as course supplements during geography classes.

7.5.3 Driving Forces for Public Awareness and Education

In business terminology, 'market drivers' or 'drivers of change' are forces that drive the direction of an industry or technology. Industry and competitive conditions change because forces are in motion that create incentives or pressures for change. The most dominant forces are called driving forces because they have the biggest influence on the kinds of changes that will take place in the industry's structure and environment. Similarly, in disaster management, there are driving forces that provide direction of disaster management in Malaysia:

Mainstreaming: is a process to fully incorporate disaster risk reduction into relief and development policy and practices. What is interesting about mainstreaming is that it redefines 'risk reduction' as not only a one-time consideration that is brought into the forefront whenever there is a disaster, but a component that is incorporated into all national development planning processes such as socio-economic development plans, poverty reduction strategies, environmental plans, and local and structural town plans.

The rationale for mainstreaming is as follows:

- Increased population densities and environmental degradation create poverty and hazards
- Disasters can affect anyone, anywhere
- Few people realize that disaster effects can be reduced or prevented through risk reduction initiatives
- The process of development and the kind of development choices made in many countries sometimes contribute to the creation of disaster risks

According to Mercy Malaysia, disaster risk reduction should not be the sole domain of one department or agency in Malaysia, but a cross-disciplinary process that is incorporated into all sectoral plans.

Climate Change: The reality of climate change is slowly permeating into the Malaysian public consciousness as storms of unprecedented intensity and frequency bring on increased reports of flooding, heavy precipitation, and landslides. Tied to the phenomenon of climate change and global warming is the notion of increased levels of carbon emissions in the earth's atmosphere. Although carbon emissions are produced by natural causes, they are also the result of human industry and activity. This brings on a second public awareness that natural calamities are brought on by human hands, a mindset that is particularly prevalent among the Malaysian public when it comes to landslides and slope failures.

Changes in Societal Perceptions and Attitudes: This is a corollary to the previous statement made about awareness of calamities brought on by human factors. Although a recent newspaper article claims that ALL disasters are manmade (due to the fact that mitigation or preparedness measures could have lessened the effects), the public still draws the distinction between *natural* disasters (such as earthquakes and tsunamis) and *manmade* disasters (such as slope failures and landslides). Not surprisingly, the public is much more tolerant of events that they deem are 'acts of nature' or 'acts of God.' However, when it comes to slope failures or landslides, the Malaysian public—in particular the urban groups living in or near hillside developments—is less lenient. Unfortunately, the public's perceptions about manmade disasters are substantiated: a paper by Gue and Partner shows that while improper designs/design errors account for 3 percent in other countries, they account for 58 percent in Malaysia.

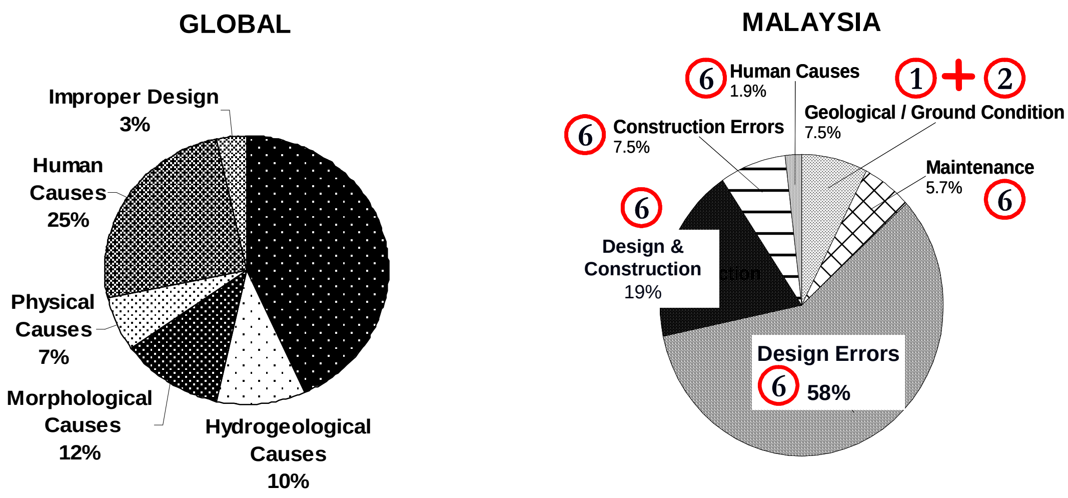


Figure 7.11: Causes of landslides worldwide and in Malaysia

This fact is highlighted quite frequently in the media, through feature articles in the Metro sections for awareness purposes or in the National news section for coverage on slope incidents.

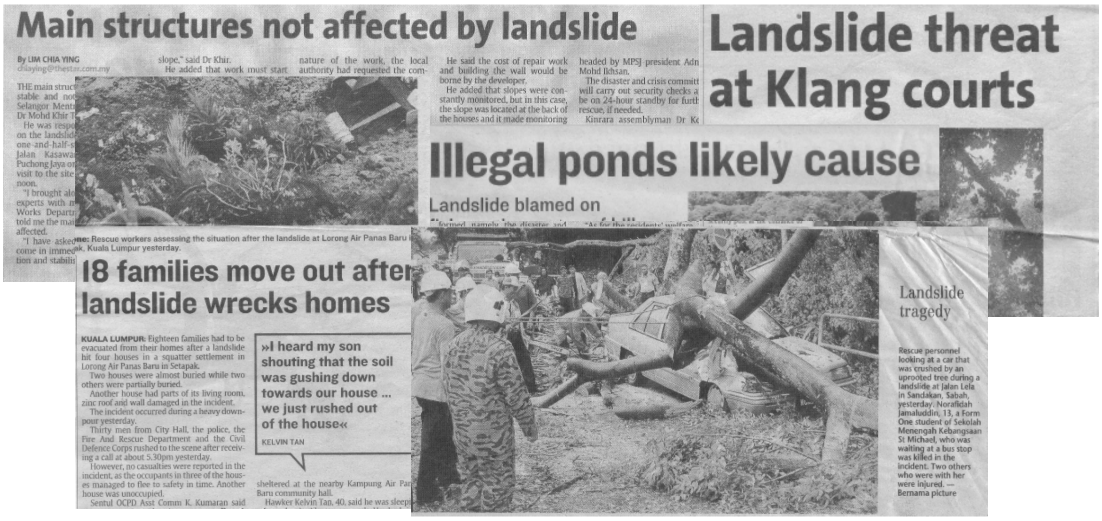


Figure 7.12: Press clippings of landslides and slope failures

Although natural landslides do occur within the country, the perception in urban areas is that many of the slope incidents could have been averted with better planning or maintenance.

In summary, the formulation of strategies for developing public awareness and education programs in slope safety and mitigation must take into account four considerations:

- That erratic weather patterns may become a permanent part of the future and people must be better equipped with coping tools and mechanisms to deal with the associated risks and hazards
- That people are becoming increasingly aware of their physical environment
- That mainstreaming is becoming necessary to propagate a preparedness culture at all walks of life and stratum
- That people are becoming aware that some disaster or incidents (such as slope failures) are caused by human activities

7.5.4 Local Needs

After finding out the current status in public awareness and education, we will need to find out what are the needs of the various stakeholders. As identified in Interim Report 1, the stakeholders are:

- Government Agencies
- Commercial
- Non-governmental Agencies
- Special Interest Groups
- Media
- Academia
- General Public

The identification of needs of each target group is important, as the delivery and the content of the programs will differ according to their user requirements.

Needs: Academia

As mentioned by Dr. Felix Tongkul of the Universiti Sabah Malaysia and the Landslide Research Center, a master plan is needed to help researchers prioritize and organize geotechnical projects. This articulation of need is echoed by other research universities, where studies and research on topics such as seismic hazard maps, shear wave propagation studies, relict discontinuities in geotechnical analysis, landslide complex studies, and GIS-based risk management are being conducted. The benefits of all these studies—already significant in themselves—would be increased if placed in the context of a master plan ("the sum being greater than the total").
Role of public awareness and education:

The Agency to disseminate information about the National Slope Master Plan (particularly the components for Research and Development and Training)

Needs: Government Agencies

Responses from questionnaires to federal and state agencies show that many agencies have public relations or communications departments within their organization and do engage in programs using a variety of media. However, with the exception of a handful of organizations—Universiti Teknologi Malaysia in Skudai, Johor and the Institute of Engineers Malaysia—almost all have no programs on awareness or education of landslides or slope issues. This is not surprising in that although Malaysia has been experiencing recorded landslides for almost two decades, slope issues only come into focus whenever there is a disaster.

What the results show is that there are a number of organizations that have existing material for public awareness and education on the topic of slopes. For example, Universiti Teknologi Malaysia has material at the university level while BOMBA Sarawak has material for the general public. Universiti Teknologi Mara's National Soil Erosion Research Centre also is a resource in promoting landslide awareness. The Agency could partner with these agencies to develop and deploy public awareness and education programs.

It was also discovered that public awareness programs are planned and implemented mostly at the state levels. It appears that there is little activity at the federal level.

Among the state agencies, it appears that Sabah and Sarawak have the most material regarding preparedness and hazard. An assumption is being made that these state agencies have a more heightened level of hazard awareness than their counterparts in West Malaysia.

Interviews with various agencies reveal that there is very little activity being focused on public awareness and education in general. Some public awareness measures have been undertaken in the past, but the frequency of the campaigns has been spotty and lacks sustainability. Landslide and slope maintenance awareness collateral has been created by IKRAM Sabah, Institute of Engineers Malaysia, and private companies through feature articles in newspapers, posters, and videos, but they have not been widely distributed to the relevant target audiences nor have the context of a larger program for continuity.

The Component's findings so far concur with the conclusions made by the Japan International Cooperation Agency (JICA) and Sabah State Government for the Borneo Biodiversity Environmental Conservation (BBEC) Programme Project:

- Lack of monitoring measures: Most of the public awareness activities did not have a procedure for monitoring or evaluation
- Not enough focus on target groups: Target group selection has not been given enough emphasis

However, according to the Ministry of Information, some government campaigns have been deemed successful, and these campaigns are currently being studied to identify key success factors as well as the measuring method used to determine the success rate of the programs. Once identified, these success factors will be applied to the formulation of PAE programs.

Two programs in particular warrant further investigation. One is Jabatan Pengairan dan Saliran's "Love Your River" campaign. In effect for 15 years to many communities throughout the country, the program is currently in the process of being re-launched. It will be interesting to find out the lessons learned in this campaign as it can be a case study in a local context.

The other agency to contact is the Ministry of Science, Technology, and Innovation, which has conducted a public survey to measure the awareness of science and technology within the country. A discussion with this ministry could reveal the kind of awareness and education measures that has been created as a result of the survey results.

As shown in the figure below, the extent of the current public awareness activity is very small (as indicated by the shaded box in the "Preparedess" phase).

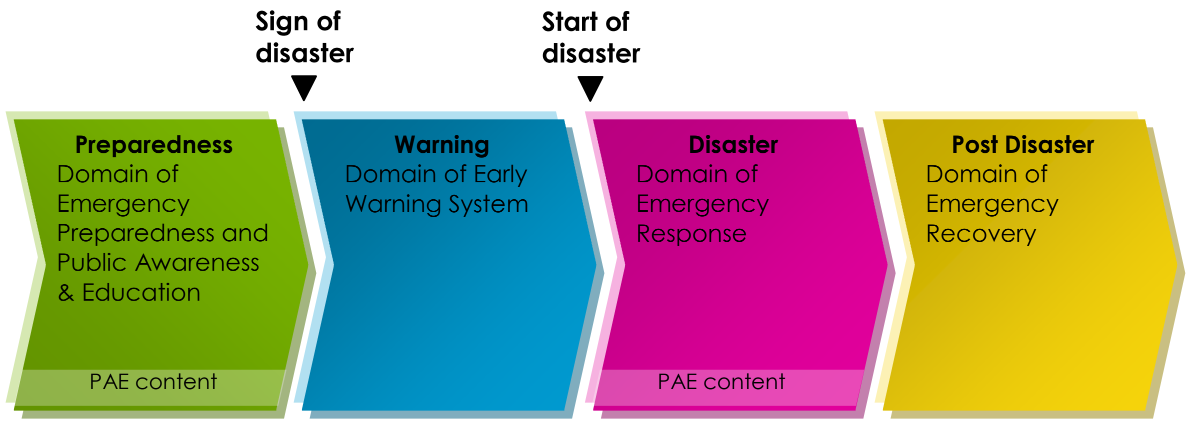


Figure 7.13: Stages of Disaster Management and PAE Content

It should be noted that the public awareness and education function is limited to only the first phase of the disaster management timeline and even at that the level of content is low. There is some activity in the "Disaster phase" in the form of media communication, but this function falls largely under the domain of the Public Works Ministry with the minister as the spokesperson rather than at the slope agency level. Currently, the agency has little say in public information matters. To be effective, the public awareness function should be extended to all the phases in the slope and disaster management timeline.

At the Disaster Awareness Day 2007 Conference in Kuala Lumpur attended by government agencies, some of the recurring themes were leadership, coordination, and sharing of information. The last point—sharing of information and avoiding redundancies in function—is a point echoed in discussions with agencies at the state and district level. For examples, discussions with the Department of Mineral and Geoscience revealed that clear separation of roles and functions was necessary to avoid overlaps with the Implementing Agencies. Likewise, a meeting with Malaysian Center for Remote Sensing revealed that the agency had a wealth of information and data that could contribute to the development of hazard maps.

At the district level, discussions with local authorities such as Ampang Jaya, a wish list from the district engineer revealed that local councils would like to see slope owners engage in more maintenance of slopes on their property. They would like to have residents assume more responsibility for slope maintenance. Residents should also know that local councils have the authority to serve notice to any property owner for disturbances to surrounding neighbors, including slope hazards. Their suggested messages to the public: safety, mitigation, and hazards and consequences caused by residents' activities. The district engineer also suggested a policy that mandates residents to do regular checking of their slopes.

At the state level, there seems to be awareness of the slope gradient-urban development guideline among the government agencies. For example, the Forestry Department of Peninsular Malaysia (Jabatan Perhutanan Semanjung Malaysia) reiterated the logging embargo on slopes steeper than 40 degrees in its literature.

Role of public awareness and education:

The Agency to clearly explain its roles, responsibilities, jurisdiction, and authority to the various agencies.

To assist front-line implementors and agencies that interface with the public

Needs: Commercial

When discussing possible corporate partners for the Agency with public relations professionals, they mentioned that some companies were interested in looking for a cause to increase marketing bandwidth through CSR, or corporate social responsibility, activities.

Role of public awareness and education: To link up such companies with Agency

Needs: Non-Governmental Organizations/Professional Interest Groups

No specific needs were articulated except that the groups were interested in engaging in joint activities that generated exposure, awareness and donations. NGOs were interested in funding for their campaigns and expressed interest in participating in programs as long as there were some funding opportunities.

Needs: Media

Media communication falls under the auspices of the government at the ministry level. National Security Council Directive No. 20 mandates the setting up of a Media Center in the event of a disaster. The Media Center is the central information authority for all reports, updates, and official statements by the government during a disaster. It is set up by the Ministry of Information, which receives updates and reports from the National Security Division. This information is then disseminated to the various members of the press and media.

However, in reality, this center is not set up in the Zone Green area at every landslide event, as evidenced by the recent Putrajaya Precint 9 incident. Reporters and media personnel enter the Zone Red area normally reserved for emergency first responders. When asked what reporters do when they cannot find a spokesperson, a New Straits Times reporter answered that they would look for alternative sources. This point has been repeated by a federal agency official who noted that the information being reported by alternate sources was not always necessarily accurate.

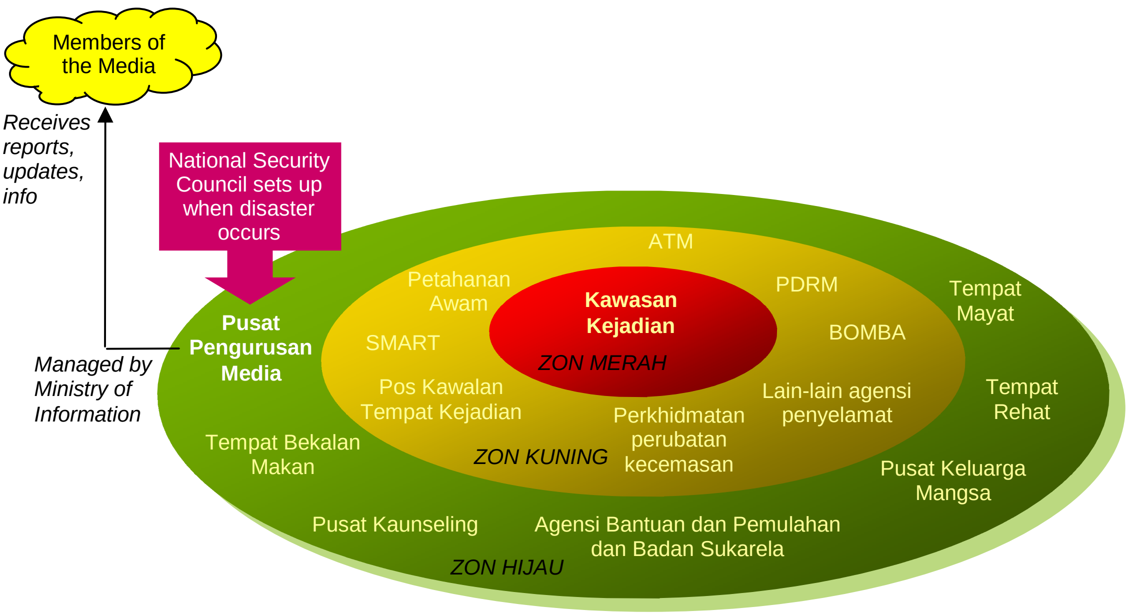


Figure 7.14: Role of PAE in Current Slope Management & Landslide Continuum

The media, particularly the newspapers, provide a consistent and comprehensive coverage on landslide and slope issues to raise a certain level of awareness to the general public. It has been noted that members of the print media are also contacted by resident associations from time to time and are fed relevant to keep key issues in the media limelight. In this way, the media is quite knowledgeable and conversant on slope issues. From time to time, the media asks first emergency responder consultants for training on specific aspects of disaster management coverage, such as production crew safety. For example, a TV media company recently asked a private emergency consultancy firm for training to ensure production crew safety while reporting at disaster sites.

Role of public awareness and education: To provide information through briefing and training sessions to the media

Needs: Residents, General Public, and Community Interest Groups

The segmentation of the general public is evident in the way people respond to slope issues. For example, individuals living in urban hillside areas coalesce and form watchdog groups and are very vocal in the government's management of the slopes. At the other end of the spectrum, there are the indigent and migrant residents who live in high-hazard areas, but are not empowered or knowledgeable enough to have a say. According to Universiti Sabah Malaysia, in Sandakan which is one of the landslide-prone areas in Sabah, the people at risk are illegal migrant workers living in rocky outcrops. Thus the needs of the target public groups vary according to their profiles in terms of their domicile, demographics, and socio-economics characteristics.

Roughly, the profiles for the public are split up according to:

- Urban
- Rural
- Agricultural

In Interim Report 1, assumptions about communication methods based on profiles were made (Interim Report 1, 'Method Selection by Target Audience,' Section 7.6.1). The assumptions—based on research conducted in the U.S.—proposed approaches that were most effective in reaching out to people of various backgrounds. In subsequent discussions with communication managers, it appears that these assumptions are valid in Malaysia and the same types of methods are being used in local public awareness and education programs.

Focus: Resident and Community Interest Groups

Although the needs of the other profile groups are equally as important, the needs of the urban residents will be highlighted in this report for strategic reasons. Firstly, they are beginning to organize into interest groups (resident associations) that apply pressure on the government through savvy use of the media, exercising of consumer and freedom of information rights, use of public forums, and pacifist articulation of grievances. Secondly, they are society's opinion makers that quite frequently drive the slope safety movement. A review of newspaper articles compiled over two years provides the perception that the citizens want more than what is currently being done by the government.

Figure 7.15: Press clipping highlighting public advocacy groups' use of the media

Thirdly, they are a growing force to be reckoned with. According to one resident association that wishes not to be named, it travels around the country providing assistance to other resident groups in asserting themselves organizationally. And lastly, the resident groups are well-educated and driven, with a vast capacity for learning. The membership of these urban groups constitute professionals from all walks of life, such as managers, entrepreneurs, lawyers, university faculty members, civil engineers, contractors, and even geotechnical engineers. They straddle two sides of the slope issue, as working professionals and as homeowners. As such, they are familiar with the issues as well as the weaknesses in the current system. Where in-house expertise is lacking in interpreting a legal document or geotechnical reports, they know where to source experts who could.

Perceptions and Attitudes

In discussion with various groups, comments revealing the interviewees' attitudes and perceptions were noted (quoted verbatim):

- Construction is 90 percent of all failures
- There is a need for proper code of practice
- Maintaining slopes should be everybody's responsibility
- Residents want a second opinion on repair or mitigation measures
- Local authorities get off scott-free (they don't have expertise, but act as regulators)
- Don't know who to contact for information in event of landslides (e.g., residents talked to private companies such as UEM and Ho Hup because they were there at the Bukit Antarabangsa landslide)
- How do you watch over JKR? They get most of the contracts, yet they are regulatory as well. Who is minding the gatekeepers?
- Residents are willing to bear the cost of maintaining new slopes on their land, but not for existing ones (the ones that exist but are not graded by the government yet)
- Who is responsible for slope failures and landslides (If proven oversight of duties, you are criminally liable)
- Local councils are not heeding the State Structural Plans, or even their own Council Structural Plans when it comes to approving hillside developments

Needs

- Tell us how to maintain the slopes
- Teach the developers on good practices and codes of conduct

- What are our rights (e.g., we should have the right to see environmental impact assessments, but in reality we are constantly denied access)
- Would like to have more educational material (some of the associations mentioned the usefulness of a JKR video on slope maintenance ("Slope Disasters and Prevention: Bencana Cerun dan Pencegahan")
- Access to documents to provide rationale for hillside development, specifically copies of all technical reports for the proposed development, measurement and contour plan, road and main drainage plan, and the development proposal report

Suggestions

During the discussions, residents even made several suggestions, some of which are already being considered by the other components in this Master Plan Study. These suggestions are not being mentioned for their content as much as an insight to how much thought is being placed by ordinary citizens on the slope issue.

- Set up a geotechnical arm
- Refer to two comprehensive documents on retaining wall: the U.S. Naval Corp and the Hong Kong manual. There is also a manual by the Ministry of Environment.
- Create a Pro-forma Guide
- Always get a second opinion on slopes (an independent checker)

In summary, from a government agency's perspective, it would be easy to foresee relationships with residents and community groups as vexing and antagonistic. But these relationships can actually aid the development of a socially responsible slope management agency. By performing the function of checks and balances and watchdog vigilance, these groups could help mold the roles and responsibilities of the slope manager and in so doing help maintain a culture of accountability among the planners, implementers, and regulators.

Interesting Side Note

This article, taken from a local newspaper, exemplifies the climate of distrust by the public with existing authorities on the topic of slope safety and management.

Star Online > Central

Saturday June 3, 2006

Landslides an avoidable danger

By K.W. MAK

THE popular sentiment among many people is that property developers are a greedy bunch and are to blame for landslides that occur near hillslope developments.

But, what about the authority entrusted by the public to protect public safety? Is the local government not empowered to take action against developers who do not comply with building orders?

"No more excuses please," said Derek Fernandez, who is Bukit Gasing Joint Action Committee chairman and legal advisor of the Section 5 and Section 10 residents associations.

There are strict laws that prevent these things from happening and the first is the Cabinet Guidelines for Development in Highlands that was passed on June 22, 2002."

The guidelines prohibit any development in an area with a gradient above 35 degrees (measured on existing contour and not after cutting and filling).

For development on gradients between 26 to 35 degrees, development can be considered, but is subject to detailed studies and evaluation whereby the developer must submit the following reports:

- An environment impact assessment report prepared in accordance with the guidelines set by the Department of Environment;
- A geological and geotechnical report;
- A risk erosion map outlining the various risks of erosion that may take place; and
- A proposal on the stabilisation measures to be taken by the developer to minimise or abate risk of erosion, landslide and destabilisation of the surrounding area.

Professionals must prepare these reports and be willing to bear any legal responsibility for the validity of their opinions to ensure that they have taken reasonable care in the preparation of their opinion.

There is also Section 21A of the Town and Country Planning Act 1976, whereby development impact proposal reports must be submitted for any development.

This report must state and evaluate the impact of the proposed development, and this includes a detailed survey of the trees, vegetation, topography, geology, contour and drainage in the area.

It is only after the local authority receives all these reports that they can consider coming out with a development order (DO).

"Even after the local authority comes out with the DO, the local authority has a duty to ensure developers comply with the DO and there should be clear visits to the site and supervision of the requirements that are important for public safety," said Fernandez.

"The excuse of insufficient manpower cannot be used, because the local authority can charge the developers extra to cover the cost of hiring the professionals needed," he said.

Section 70B of the Street, Drainage and Building Act 1974 provides the local authority with the power to issue an immediate stop-work order.

To ensure landslides do not occur in hill slopes, the local authority can impose a two-stage DO whereby the first stage requires the developer to build the required structures for hill stabilisation and erosion protection, which includes retaining walls and drainage.

Only after the local authority is satisfied with the technical requirements constructed in the first phase can the second stage of development (of the actual properties) be undertaken.

The two-stage DO is not a requirement by law, but it is a prudent practice and City Hall (DBKL) has issued such an order for Bukit Gasing.

The order was issued in the 1990s to Gasing Meridian Sdn Bhd," said Maxwell Towers Residents Association chairman Victor Oorjitham.

"The developer was unhappy with the requirements as the two-stage DO would incur additional cost and brought the case to the courts, where judgement was found in favour of DBKL all the way to the way to the Appeals Court on April 8, 2003."

Maxwell Towers is an apartment situated near Bukit Gasing.

Fernandez said all the relevant documents should be made public so that the people can be certain that the local authority took the necessary steps to prevent such mishaps from occurring.

"The perceptions that the local government is immune to prosecution because of the Federal Court judgement on the Highland Towers case is incorrect, as the judgement only covers decisions made under the Street, Drainage and Building Act 1974," added Fernandez.

7.5.5 Other Issues

In addition to the situation analysis and identification of local needs, there are other issues that need to be considered as listed below.

Treatment of Chronic vs. Emergencies

The distinction between landslide disasters/emergencies and chronic slope failures was made by Prof. Morgenstern of the University of Alberta who suggested that different approaches should be taken to address these different facets of slope safety management.

Perception Regarding Natural vs. Manmade failures.

People look at manmade disasters differently from natural disasters. The belief is that it's not an 'act of God' as much as an 'act of human negligence'. Hence the need for a proper system set-up and accountability BEFORE the disaster, as well as public relations activity.

Differentiate between Land Use Issues and Safety Issues:

In unstructured discussions about slope issues with member of the public, the topic of the discussion kept returning to the issue of land gazetting. A distinction must be made between the Agency, whose mission is the safety of slopes and more engineering-related responsibilities, and agencies such as local councils and Land Planning offices that make and manage land use decisions.

Notion of Risk:

Planners must know the threshold of tolerable and acceptable risks within the communities so that the structural and non-structural mitigation measures and solutions are commensurate with the public's accepted level of risk.

Insurance:

Slope insurance is provided in Malaysia, but the insurance industry lacks the knowledge and expertise to accurately measure slope risks. A representative from the Insurance Association of Malaysia stated that further information from the Agency in risk assessment would be helpful to the industry.

7.5.6 SWOT Analysis of Public Awareness In Malaysia

In this section, the findings presented in the previous sections are consolidated into a SWOT analysis matrix. The matrix serves as the basis for strategy formulation, i.e., what skills or capacity are currently lacking, what areas to strengthen, or what opportunities to capitalize on.

Table 7.6: SWOT analysis of public awareness and education in Malaysia

Strengths	Very active mass media heightens public awareness of natural and manmade phenomena
	Increasing awareness within the business community and Corporate Social Responsibility is on the rise
	Residents mobilizing into community interest groups shows interest in community issues
	Public shows capacity to become familiar with geotechnical concepts and legal instruments
	Concepts such as Disaster Risk Reduction and Mainstreaming emerging into the language of emergency planning agencies
	Public is receptive to information
	Long-term plan formulation is starting to take root, as opposed to ad-hoc programs
	More and more public awareness and education programs in the classroom for kids
Weaknesses	Lack of national long-term DRR plan that other sectoral plans such as the National Slope Master Plan can follow or integrate with. Lack of national direction.
	The lack of national direction tends to make the actions of the government reactive, rather than pro-active
	Widespread cynicism over the intentions and capacity of government agencies. In particular, local councils take the brunt of blame.
	Lack of sufficient geotechnical knowledge by front-line implementers (local council)
	No coherent identity of the Agency
	Awareness of disasters is present, but there is no awareness of the preparedness and mitigation aspects (media wants to report bad news; creates 'state of fear or malaise')
	DRR is not addressed in Malaysia Plans
Opportunities	Climate change awareness sensitizes the public to other calamities and spur action
	Local councils are vilified by the public, but the image of the Agency is non-existent in the public's eye and not yet tarnished
	Channel the energy of resident groups away from negative (protests)

	and towards positive (risk reduction activities)
Threats	Saturation of public awareness and education programs in schools (will children retain the information in order to be effective?)
	Bad PR and image damage by the other units of JKR may tarnish the Agency by association
	Failure of programs are visible (string of landslides after the National Master Plan kicks in can be embarrassing and instigate public review)
	If programs work too well and there is a period of no failures, program budgets can get cut back.
	If there are no slope failures or landslides, the public will lose interest in the programs.

7.5.7 Custodian Agency

In the previous section, the current status of the public awareness and education for slopes and landslides were reviewed. This section shall look at the current status o f the organization responsible for slope management, slope engineering, and subsequently public awareness and education. A review of capacity and capability is necessary such as any gaps or shortfalls can be addressed through additional training, partnerships, and human resources development.

The custodian agency for slope management and engineering is the Public Works Department's Slope Engineering Branch. Its immediate goals are to:

- Reduce risks and fatalities from landslides
- Increase the safety standard of engineered slopes
- Regulate new hillside developments
- Effective use financial and manpower resources in slope repair and maintenance works
- Provide education to the public on slope safety, maintenance and prevention

To carry out the objectives, the Slope Engineering Branch works as a section under the Public Works Department and is made of six active units comprising slope safety, slope management, IT and standards, research and development, forensic investigation, and quality and training.

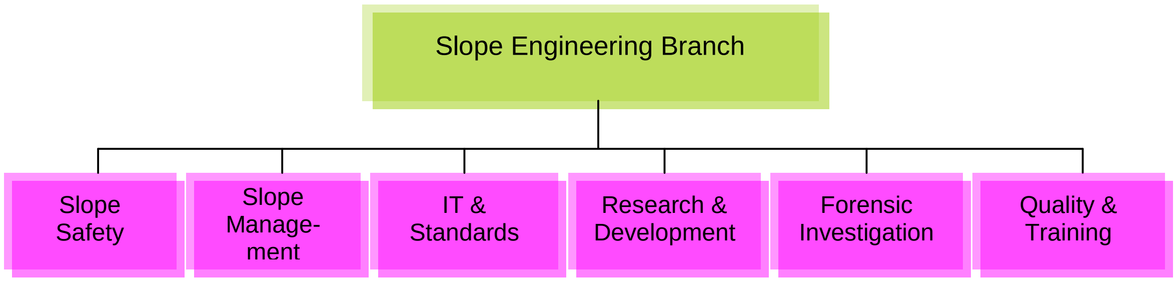


Figure 7.16: Organization of Current Slope Organization

The Slope Engineering Branch is a panel member in the Technical Committee for Development of Environmentally Sensitive Area of Selangor and on the Committee for Hillside and Highland Area Development. It is also chairs the Landslide Working Committee.

7.5.8 SWOT Analysis of the Current Organization

A SWOT analysis of the current organization is shown as follows:

Table 7.7: Breakdown of respondents by category

Strengths	Firm leadership and vision
	Clear mandate
	Management skills
	Image of the Slope Engineering Branch untarnished
	Access to partner agencies to increase capacity
Weaknesses	Role of Slope Engineering Branch not known by the public and hence is not in the loop when slope emergencies arise
	More technical, on-the-ground skills will be required with new responsibilities
	Bad PR and image damage by the other units of JKR may tarnish the Agency by association
	Other PWD units competing with Slope Engineering Branch for disaster recognition (e.g., PWD Road)
	Status of unit (cawangan) limits Slope Engineering Unit's authority to enforce and regulate; needs legislation
	Current staff size of 60 not sufficient to carry out National Master Plan activities
	Failure of programs are visible (string of landslides after the National Master Plan kicks in can be embarrassing and instigate public review)

Opportunities	Perception of 'brand new' agency makes it easier to develop positive image of the Agency
	Role model for coordination and authority on slope issues
Threats	The Agency can become the target of the public's anger over land use decisions
	Budget cut-backs due to string of no landslide activity
	Public expectations of Agency's deliverable may be too high

7.5.9 Strategic Direction of the Slope Engineering Agency

In the Interim Report 1, it was stated that the role of the agency will begin as advisory capacity, then gradually expand to include monitoring, and eventually gain authority to exercise enforcement. Subsequently, during the course of discussion among the study components, it was agreed that this development trajectory of the organization be following. For the short term, then, the Agency shall assume the role of advisory to the various government agencies.

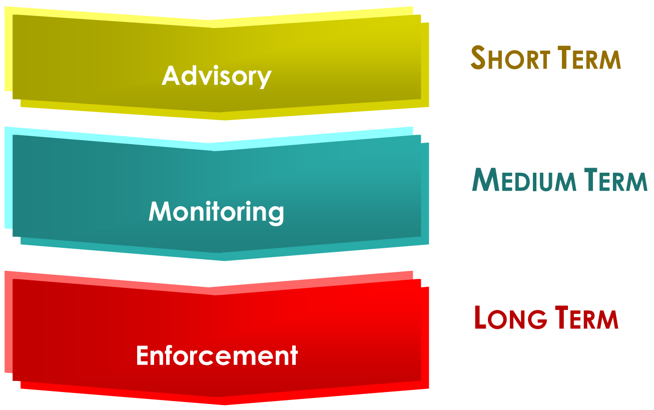


Figure 7.17: Projected functions of the Agency

7.5.10 Short- Term Objectives

CKC Organizational objectives/thrusts for the short term are:

- Cataloguing all the slopes
- How to monitor
- Maintenance of the slopes
- Repair of the slopes

7.5.11 Proposed Organizational Structure

The organizational structure of the Agency was created by the Policy and Infrastructural Framework component of this Study. The rationale for the organizational model is explained in the PIF Interim Report 2. What is of relevance to public awareness and education is the placement of this function in the Administration and Resource Planning Division of this organization, and consists of community relations, inter-agency relations, and public information.

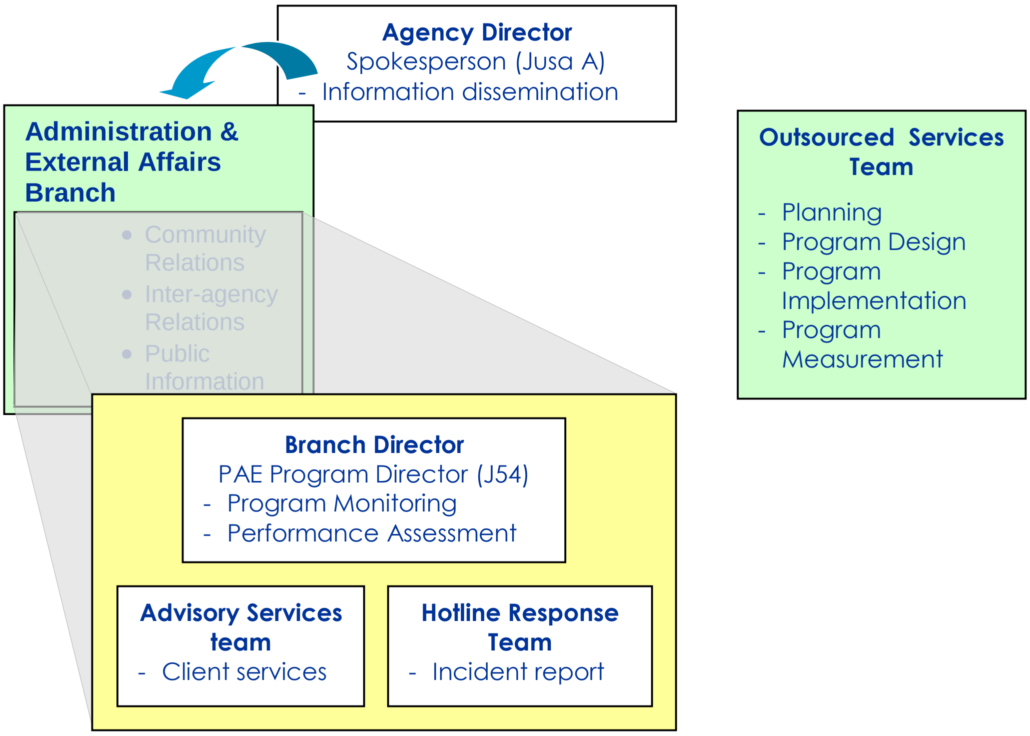


Figure 7.18: Organizational Structure of Public Awareness and Education Function in Slope Engineering Agency

As shown in the figure, public awareness and education activities shall be outsourced rather than consolidating them into the day-to-day activities of the Slope Agency. The reason for this is because the core business of the Slope Agency is first and foremost slope engineering and slope management. As such, all resources and skills should be developed for the core services and capabilities. Thus, any ancillary services such as public relations and public awareness should be outsourced.

7.5.12 Organizational Needs

The organizational needs of the Agency listed as follows are addressed in the internal strategies.

- Good communication skills
- Adequate capacity
- Designated spokesperson
- Ability to conduct issues/crisis management
- Sufficient resources for program execution

7.6 Recommended Strategies

7.6.1 Introduction

The following are the key strategies for an effective public awareness and education plan.

7.6.2 Strategic Thrust

To provide needs-based awareness and education programs that encourage greater public participation to various target groups

Table 7.8: Strategic Thrust

Strategic Thrust	Strategies
Provide needs-based awareness and education programs that encourage greater public participation in various target groups	**7.1** Build public awareness capabilities of implementing agencies **7.2** Conduct public awareness programs based on user needs requirements **7.3** Implement public awareness measurements

In the strategic thrust mentioned above, public awareness and education has been coined with the term "needs based", which places emphasis on the kind of information that must be disseminated in order for each target group to enact the desired behavior, i.e., actively engage in slope maintenance practices, take precautionary and preparedness measures, or attain a safety-oriented mindset. For example, for local governments, it may mean learning more about the existence of maintenance guidelines. For communities, it may mean learning more about the nature of hazards that affects them and adopt precautionary measures. And for schoolchildren, education may include simple facts about landslides and how it impacts the surroundings around them. In each case, awareness provides target groups leads to education that empowers them to make changes on the current status of slope problems.

7.6.3 Strategies

This strategy is required before any public awareness and education programs are to be implemented. Capacity building of the Slope Agency and other partner government agencies is necessary so that the public awareness programs can be carried out efficiently and effectively.

Strategy 7.1: Build public awareness capabilities of implementing agencies	
Action 7.1.1:	**Set up and maintain the Public Communication function**
Action 7.1.2:	**Produce marketing collateral for each target group**

This strategy is a prerequisite to the implementation of any public awareness and education programs can. Capacity building of the Slope Agency and other partner government agencies is necessary so that the public awareness programs can be carried efficiently and effectively.

Action Plan 7.1.1: Set up and maintain the public communication function

Set up a Public Communication function within the Agency to communicate effectively with the public. This involves setting up a team for:

- graphic design and production
- news production

- multimedia production
- risk issues management
- event management
- target group liaison
- domain expert input and content development
- technical writing, editing, and illustration
- photograph management and archiving
- public relations

The function of the public communication department is to establish goodwill with the public, to create awareness of the target groups' respective roles and responsibility in slope safety, and to disseminate educational material to deepen understanding. Out of this, one of the key activities is appointing a spokesperson. The spokesperson may not necessarily be the emergency/public information spokesperson during a landslide, but he or she will be the key contact person for any queries on general information by the public.

Action Plan 7.1.3: Produce marketing collateral for each target group

This is similar to Action Plan 7.1.1 in that this is an activity for setting up the public communication function. What is more relevant here is not so much the reminder to have brochures, pamphlets, posters, and other material ready prior to program launch, but that they must be catered to the level of understanding and preferences of the target audience. Target language, choice of visuals, and the acceptable amount of jargon used must be carefully considered.

Strategy 7.2: Conduct public awareness programs based on user needs requirements

Develop appropriate methods and implement programs to the target groups

The ultimate purpose of public awareness and education programs is to encourage changes in behaviour within the target audience. This could be manifested as a change in practice, habit or mindset. Therefore it is important to create programs that are based on the target audiences' needs and requirements.

Action Plan 7.2.1 Develop appropriate methods and implement programs to the target groups

As it will be highly ambitious to target the entire country for awareness and education programs, the implementation plan should start with areas of high hazard and high risk. However, as risk assessment studies and hazard mapping are still under development, planners will base target areas on historical events where landslides have been most prevalent. Communities in these areas will be targeted, and it is expected that results from public awareness and education activities will be positive because of the pre-existing awareness of landslide hazards.
As mentioned throughout this study, communities in areas of high risk will be will be targeted. The reasons are two-fold: one, the high risk groups are priority because of the obvious danger and two, the prevalence of past landslide occurrences in their area will make them more receptive to public education programs.

To start with, the areas targeted will be based on historical records. Once hazard and risk maps are developed, then the target areas will be based on risk prioritization.

The following figure shows the distribution of landslide occurrences throughout the country.

Figure 5.18: Landslide occurrences in Malaysia (source: Public Works Department)

The list shows that the areas experiencing the most landslides since the 1970s are:

- Selangor
- Wilayah Persekutuan
- Pahang
- Penang
- Sabah

In the Early Warning System report of this study, the states for which early warning will be rolled out are listed below. This roll-out is based on the same premise of frequent occurrence.

- Short-term:
  - Wilayah KL
  - Selangor (Ulu Klang)
  - Pahang (Cameron Highland)
  - Penang
  - Sabah
- Medium-term:
  - Cameron Highland
- Long-term:
  - Other landslide-prone areas

As mention previously, there are a number of methods that can be used to target audiences, and a key to success is to use methods that are a normal part of the target audience's communication channel.

Strategy 7.3: Implement public awareness measurements	
Action 7.3.1	**Obtain a baseline measurement of the various target groups through market research**
Action 7.3.2	**Conduct surveys to follow up on changes in awareness and knowledge level**

All programs must be measured and evaluated to determine whether they are effective.

Action 7.3.1 Obtain a baseline measurement of the various target groups through market research

Getting baseline measurement is important as it serves as a reference against which future measurements can be evaluated. Baseline parameters should include, but not be limited to, knowledge, attitudes, propensity to take action among the population of target groups. Comparisons between the baseline and subsequent measurements can let planners know whether awareness and knowledge levels have increased as projected.

Action 7.3.2 Conduct surveys to follow up on changes in awareness and knowledge level

Follow-up surveys and discussions are important tools in letting planners know whether the programmes are working or not.

Observing and assessing behaviour of the target groups during drills and actual landslide incidents is another way to find out whether programmes are working and messages are understood by the target groups. However, due to the high cost of information gathering in terms of logistics as well as threat to life and property, this method is not the first method of choice.

Public awareness and education is a form of social engineering, which is fluid, dynamic, and often takes a long time to achieve the results. Programmes should be closely monitored and modified depending on the information absorption and acceptance by the various target groups.

7.7 Implementation Framework and Plan

7.7.1 Introduction

Implementation of public awareness and education programs must be guided by a roadmap or a vision of where the disaster risk reduction community in Malaysia is headed. Based on information gathering through seminars, discussions, and interviews with various disaster risk reduction players in the country, there seems to be a trend towards strong community involvement, which is one of the key factors in achieving stakeholder interest and sustainability of programs. More and more, the dialogue between policy makers and the audience is that of active participation.
The figure below shows the evolution of public awareness and education from a predominantly government-led approach towards disaster risk reduction to a predominantly community-led one.

In the initial stages of public awareness and education, the target groups must be convinced and cajoled into accepting and rationalizing hazards and risks in their communities, and becoming into mitigation considerations.

In the medium-term, the target groups engage in pro-active measures and start taking interest in becoming part of the mitigation efforts.

In the long-term, the stakeholders of the disaster risk reduction efforts are the community members themselves. They have a strong sense of accountability because the ideas come from themselves.

Figure 7.19: Disaster Risk Reduction Roadmap for Slope Safety Awareness in Malaysia

		Capacities Built	Rationale
Short-term	**GOVT-LED DRR** 	Government initiative. Government plans and implements. E.g., public campaigns	Government provides national direction and promote coordination on large scale
Medium-term	**COMMUNITY-INVOLVED DRR** 	Government and community initiative. Government encourages strong community participation in programs E.g., town watching, school watching	Leads to hand-on understanding of risks and effect of mitigation
Long-term	**COMMUNITY-LED DRR** 	Community initiative. The community plans and implements. E.g., U.S.'s Project Impact	Programs work when there is a sense of ownership

Examples of public education in the varying stages exist in, but are not limited to, countries such as Japan and the U.S. In Japan, communities have created committees whereby hazard identification, hazard maps, emergency response plans, and organized neighborhood walk-abouts for spotting potential hazards are conducted by the residents themselves.

In the United States, the Federal Emergency Management Agency (FEMA) has passed the onus of the entire planning and implementation process to communities in target cities. It works on a basis of endowing financial grants to high-risk communities, and the community involving members such as business owners, home-owners, emergency management professionals, and trainers create a plan and executed it according to

FEMA guidelines. Progress is checked by FEMA and reviewed on a yearly basis. An annual focus group discussion at the national level enables knowledge transfer and problem solving among the various communities.

In summary, experience shows that a one-way communication does little to make an impact on the public in terms of disaster awareness. The conclusion that is drawn from observing international experiences is that success is high where there is a sense of ownership among the stakeholders, when there is a sense that ownership of mitigation ideas comes from themselves.

This vision has been discussed with National Security Council personnel, but a national roadmap for disaster risk reduction has as of yet to be finalized. It is advised that future planners and practitioners following the national slope master plan adjust the goals within this report to conform to the national mainstream agenda as and when it is introduced.

7.7.2 Implementation Process

Unlike most development projects that progress linearly, public awareness and education programs are recursive in nature, meaning that programs are repeated over a period of time. This is because messages must be repeated over time—two of the seven principles of communication are continuity and consistency—and because social changes takes time to take effect.

An implementation plan based on these factors would have programs repeated on a yearly basis, but with different messages and tactics according to the strategic intent of the Agency. External events also affect a year's implementation agenda: a string of landslides and slope failures would have the Agency provide messages of reassurance and renewed commitment to loss mitigation measures and slope engineering works.

Basically the programs are implemented according to the steps below.

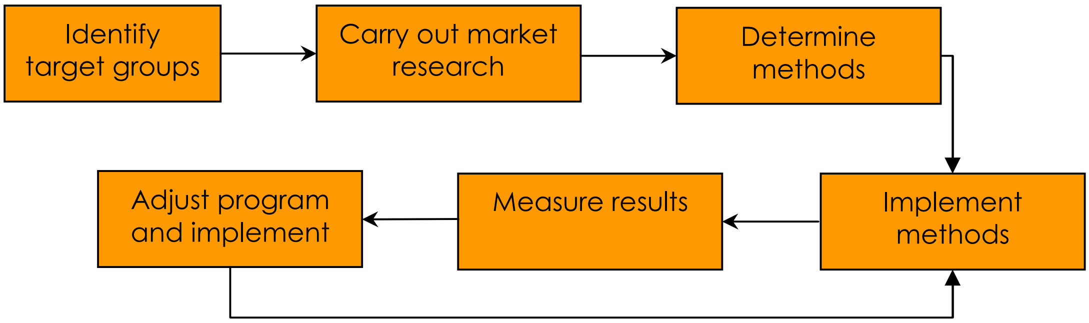


Figure 7.20: Flow chart for program implementation process

7.7.3 Implementation Structure – During Preparedness and Mitigation Phase

Provide education to all the various target groups on the following main topics:

- Slope safety
- Slope maintenance
- Mitigation measures

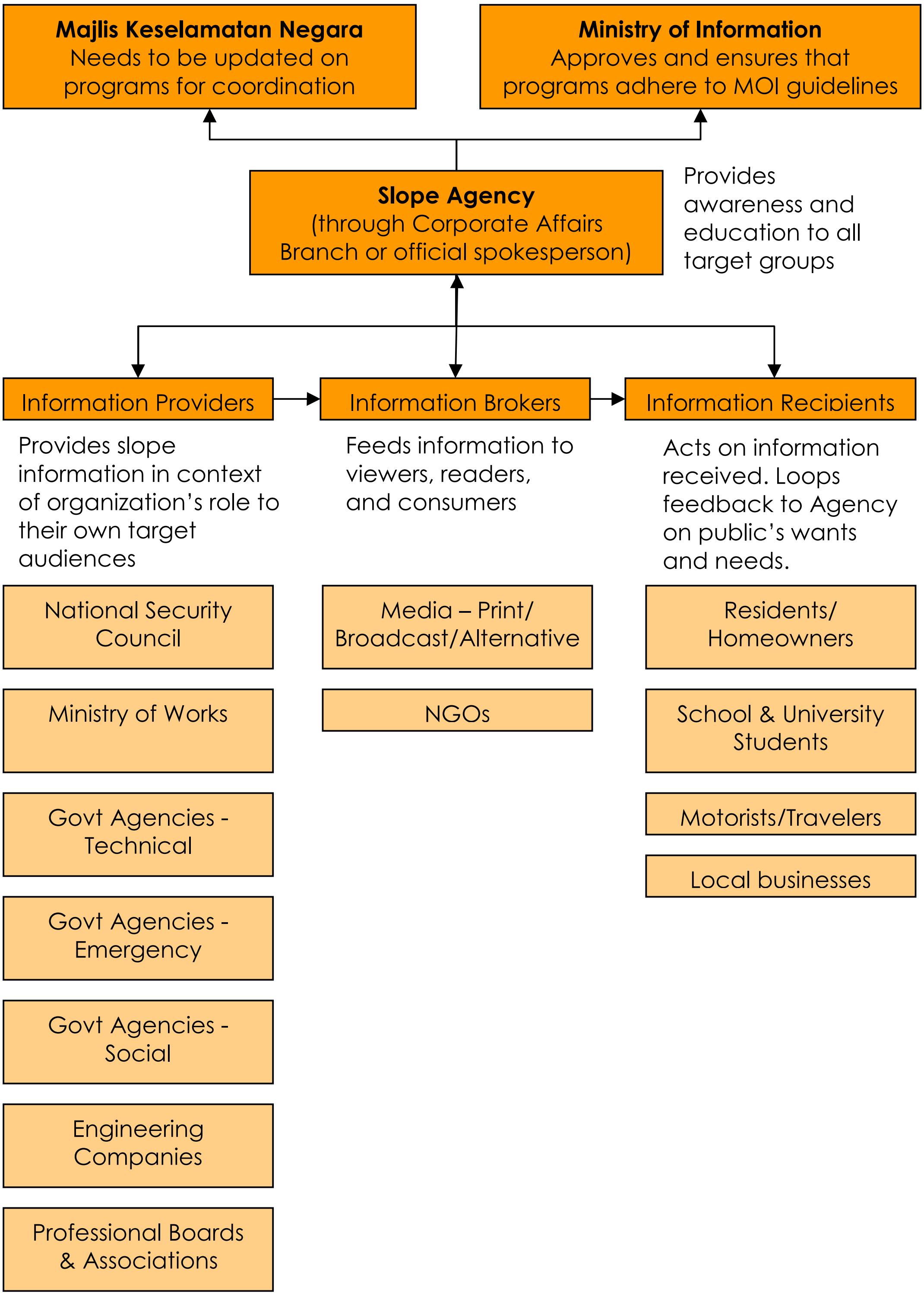


Figure 7.21: Implementation Structure – During Warning and Response Phase

During Warning

Monitor the effectiveness of the public awareness and education function in real-time through observed response rate to the warnings and public information as well as the public's behavior.

During Response

Ensure that lines of communication between the official incident spokesperson and the Agency are open during this phase so that appropriate and accurate announcements to the public and the media can be made.

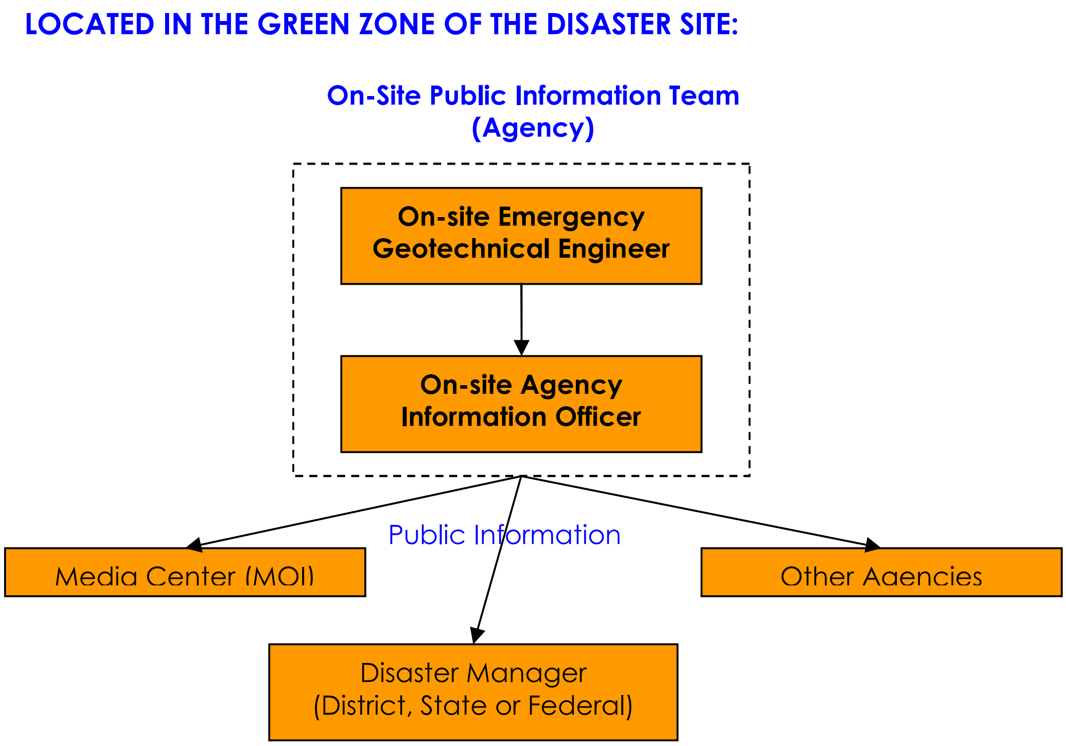
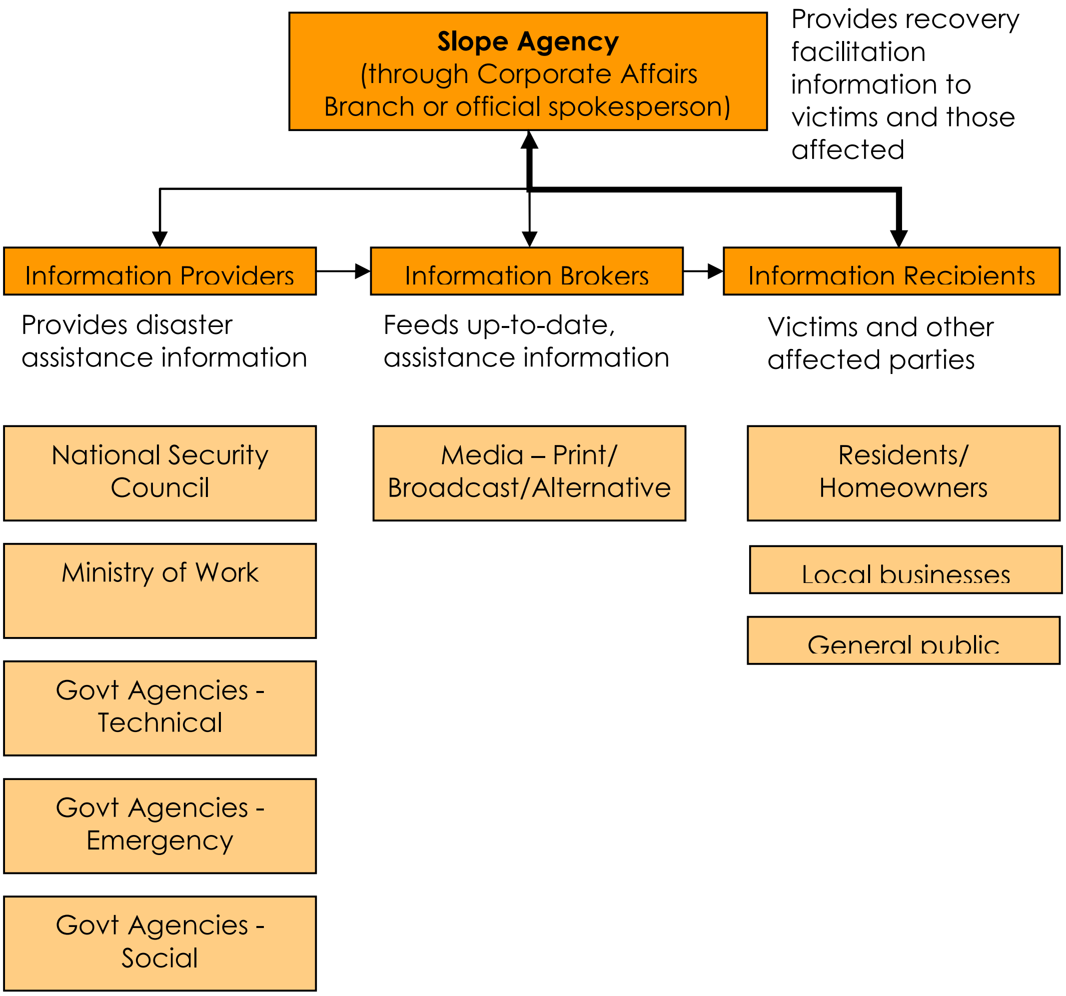


Figure 7.22: Implementation Structure – During Recovery Phase

During this phase, it is vital to ensure that communication lines are open to the incident spokesperson. The role of public awareness and education is to take note of failures in communication breakdown, inability of the public's capability to react, or otherwise act on safety or emergency measures the public was taught during the education process. Corrections based on observations made should be made for subsequent programs.



7.7.4 Implementation of Action Plan

The approximate annual budget for carrying out Public Awareness and Education campaigns is between RM2.0 to RM2.18 million and falls under the operating expenditure of the overall Agency budget. This is based on a campaign targeting the general public and specific areas of high-risk within the country, and aiming at major target groups such as government, private industry, media, schoolchildren and young adults, residents and homeowners.

The budget outlines the costs of carrying out activities for the public awareness and education programs. It includes program implementation expenditures such as brochures and seminars and cost of outsourcing. It does not include the salaries of the Slope Agency staff, as it is already factored in the section for Policies and Institutional Framework.

The budget shows a higher operational cost in the first four years of the program due to extensive brand building and agency recognition efforts of the Agency. Therefore the first phase of the program is not only to introduce awareness and education into the consciousness of the population, but also the introduction of a 'new' custodian agency.

No.	Action Plan	Who	When/Cost (RM Million)			
			Phase 1		Phase 2	Phase 3
			(2009 – 2010)	(2011 – 2013	(2014 – 2018)	(2019 – 2023)
7.1	**Build public awareness capabilities of implementing agencies**					
7.1.1	Set up and maintain the public communication function	CKC/SEA	0.09	0.14	0.23	0.23
7.1.2	Produce marketing collateral for each target group	CKC/SEA	1.69	1.84	4.33	4.33
7.2	**Conduct public awareness programs based on user needs requirements**					
7.2.1	Develop appropriate methods and implement programs to the target groups	CKC/SEA	2.14	3.08	4.99	4.99
7.3	**Implement public awareness measurements**					
7.3.1	Obtain a baseline measurement of the various target groups through market research	CKC/SEA	0.31	0.16	0.27	0.27
7.3.2	Conduct surveys to follow up on changes in awareness and knowledge level	CKC/SEA	0.13	0.19	0.32	0.32
		Sub Total	**4.36**	**5.41**	**10.14**	**10.14**
		Grand Total	**30.05**			

7.7.5 Critical Success Factors

The success of the public awareness and education programs hinge on *engagement*—that is, the participation of the various target groups to engage in activities as promoted in the program messages. Although there are other factors that contribute to the success of public awareness and education programs, engagement is the key element for building awareness, getting acceptance of messages, and achieving behavior change.

Table 7.9: Critical Success Factors

Critical Success Factors	Description
Engagement	Build awareness
	Accept and internalize messages
	Achieve behavior change

The other factors that contribute to success are as follows:

Identify target audience groups - Incorporate slope safety and mitigation programs for schools using disaster risk reduction framework and curriculum planners' approaches. Involve developers, construction companies, and other slope disturbers in activities. Educate the media so that they can be part of the information dissemination process.

Educate them based on their needs and functions as identified through market research - Incorporate slope safety and mitigation programs for schools using disaster risk reduction framework and curriculum planners' approaches. Involve developers, construction companies, and other slope disturbers in activities. Educate the media so that they can be part of the information dissemination process.

Target vulnerable areas first - Incorporate slope safety and mitigation programs for schools using disaster risk reduction framework and curriculum planners' approaches. Involve developers, construction companies, and other slope disturbers in activities. Educate the media so that they can be part of the information dissemination process.

Create awareness of hazards, risks, and consequences using mass media and grassroot approaches - Incorporate slope safety and mitigation programs for schools using disaster risk reduction framework and curriculum planners' approaches. Involve developers, construction companies, and other slope disturbers in activities. Educate the media so that they can be part of the information dissemination process.

Develop programs that consider action to be taken by the public before, during, and after landslide incidents - Focus on mitigation, prevention, and preparedness aspects of landslide incidents to create a pro-active mindset.

Develop programs that consider chronic slope issues – Finally, publicly follow through on projects so that success stories can be created

7.7.6 Key Performance Indicators

Although engagement was identified as the main critical success factor for ensuring success of the public awareness and education programs, it is not equal to the end result of the programs, which are awareness and behavior change.

There are two indicators that the programs are working: increase in the number of people aware of slope hazards and risks, how many people know what to do, and how many people have converted that knowledge into change of behavior.

Performance shall be based on the following:

- Awareness – Percent Increase from baseline and year-to-year
- Adherence to Messages – Survey measurements; performance in drills

Table 7.10: Key Performance Indicators

Critical Success Factors	Key Performance Indicators	Target		
		Phase 1	Phase 2	Phase 3
Engagement Create awareness and change in attitude on target groups and stakeholders	Percentage of increase in awareness from baseline based on survey measurements	40%	60%	80%
	Performance during landslide drills based on survey measurements	60%	70%	80%

Note: It is important to note that these targets shall be aimed at communities where programmes have been implemented, and not the population at large.

It is important to note that these targets shall be aimed in communities where programs have been implemented, and not the population at large.

7.7.7 Outcome

In the context of public awareness and education, 'outcome' is what happened as a result of all the media coverage, seminars, advertising, and other activities carried out in the program. 'Output' is the number or quantity of material that was disseminated, for example, the number of brochures distributed during a specific campaign. Outcome then is the measure of what resulted from the output.

To articulate the measure in a single statement, we shall combine the program's objective, or strategic thrust introduced earlier in this plan. The articulation is thus:

To provide needs-based awareness and education programs that encourage greater public participation to various target groups such that awareness among the target groups are 40 percent in Phase 1, 60 percent in Phase 2, and 80 percent in Phase 3. Adherence to messages and eliciting the desired behavior such as actively initiating or participating in a community-based mitigation program are set at 60 percent in Phase 1, 70 percent in Phase 2, and 80 percent in Phase 3.

7.7.8 Summary

Although this plan presents the rationale and mechanisms for deploying a public awareness and education plan, as a social engineering endeavor it is not easy to predict the outcome as humans are complex beings and the reasons for not accepting the programs and message are myriad. However, significant inroads are being made in the area of disaster risk reduction in Malaysia as a whole, and there is a greater level of cooperation among the government agencies, civil societies, NGOs, and other stakeholders in this area than previously. It has been stated by UN-ISDR that 60 percent of the world's natural disasters have been occurring in Asia-Pacific, and with this realization and in the context of greater cooperation and growing awareness of the public and private's responsibility in disaster management, the public awareness and education initiative on slope safety is expected to take root and thrive.

APPENDIX 1 (A): DATA COLLECTION METHODOLOGY

Data collection was based on primary and secondary sources. Primary sources constituted questionnaires, interviews, forums, and discussions with Government agencies, NGOs, and other stakeholders. With the exception of the visit to Hong Kong, most of the primary information that was gathered served to *provide a picture of the status quo in Malaysia* insofar as public awareness and education activities are concerned and it enabled the identification of pertinent issues and challenges being faced.

Information from secondary sources, on the other hand, consisting of reports from international agencies, public education material from other awareness programmes, and general geotechnical information, and tended to be prescriptive. *Information gleaned from these sources serves to facilitate the setting of benchmarks and formulation of a model for public awareness and education programmes in Malaysia*.

Using primary and second sources of information, a description of the current situation and a proposed model can be elucidated as explained in the following sections.

In assessing the methods used for primary data collection, one of the interesting discoveries made during the course of the project was the relationship between the questionnaires and the agency visits. At the outset of the project, much emphasis was placed on the importance of getting a high response rate from the questionnaires. However, it turns out that little meaningful information can be extracted from the questionnaires as many of the questions were not answered as fully as expected. Instead, the questionnaires merely served to reinforce issues and points brought up in the face-to-face discussions with individuals at agency meetings. Thus it turns out that insightful, qualitative information are gathered during the agency's visits and road shows, while quantitative information (the frequency of the qualitative information) was derived from the questionnaires. While the questionnaires themselves did not reveal much information, they are effective in identifying agencies that need to be visited for gathering further information.

A final note on the road shows and visits is that many of the interviewees have stated that a face-to-face presentation or verbal explanation clarified the objective of our request for information from them. Thus, as painstaking and time-consuming as the visits are, they are valuable in gaining support and understanding from the stakeholders and relevant agencies for the Master Plan study project, and it is hoped that this effort will contribute positively to any change

Questionnaire Feedback from Federal Agencies

Questionnaires were sent to the 60 Federal agencies. Out of these, 23 replied and returned responses. The breakdown of respondents is shown in the table below.

Table 7.1: Breakdown of respondents by category

N=23	Frequency
Missing ID data	2
Federal agencies	20
University/College/School	2
NGO	1
Private sector	3
Total	28

Fifteen of the respondents were from the Federal Government, two from the university/college/school, and four were from the private sector.

Question 7.1.1: Do you have a public relations or public affairs department within your organisation?

Out of 23 respondents, only the Atomic Energy Licensing Board reported that it does not have public relations within their organisation. Others have the public relations function handled by various departments within their organisation. According to the Department of Survey and Mapping Malaysia, the responsibility is handled by the Director of Survey (Planning, Research and Development). The Malaysian Highway Authority (MHA) has its human resource and management services department handle the public relations, while at Utusan Melayu (Malaysia) Berhad, the Corporate Communication handles this responsibility.

Question 7.1.2: Do you have an overall communication strategy?

Fifteen organisations (65%) have an overall communication plan. Out of these, eight of the organisation practices are stand-alone plan and nine are inter-related with other agencies. Only one organisation practiced both stand alone strategy and inter-related with other agencies. Five organisations did not answer this question.

Question 7.1.3: Are there existing public disaster awareness programmes?

Six organisations (26%) had an existing public disaster awareness programme as compared to seven (30%) organisations that did not have any public disaster awareness programme. Eight organisations did not answer this question. Although Jabatan Kebajikan Masyarakat organisation did not have the programme, it provided a SOP workshop. Information Department Malaysia held an awareness programme on "Langkah Menghadapi Banjir" and Direktorat Pengurusan Krisis & Bencana also had a talk within the state. Only Universiti Teknologi Malaysia in Skudai, Johor had an awareness programme on slopes.

Question 7.1.4: Do you do the planning or implementation of the programmes or both?

There were no replies for this question.

Question 7.1.5: How successful were the disaster awareness programmes?

There were no replies for this question.

Question 7.1.6: What do you think are the key success factors of such programmes?

There were no replies for this question.

Question 7.1.7: What form of media did you use to convey the awareness messages?

The following table shows the type of media used by the organisations to convey the awareness messages.

Table 7.2: Types of media used

Media	Frequency
Television	7
Radio	5
Static displays (posters)	3
Exhibits and road show	6
Print	5
Internet	6
Others	0

Television (21%) was the most widely used for disseminating awareness messages while static display was the least used (9%).

Question 7.1.8: How is feedback information on the programmes relayed to you?

There were no replies for this question.

Question 7.1.9: What key messages to the public has your organisation conveyed in the area of landslide mitigation?

Three organisations conveyed some messages to the public in the area of landslide mitigation, which are as follows:

- Find out if there have been landslides in certain areas and whether they would happen again. Check for signs that the ground might be moving (e.g. leaning trees, retaining walls or fences that are slanting)
- Awareness signs with appropriate number and sizes (meaning not clear and will have to referred back to the respondent)
- Report, interview, and update (meaning not clear and will have to referred back to the respondent)

- The Government must draw up effective policies for highlands, catchments areas, hill slopes and soil conservation throughout the country. Law enforcement must be ensured in all development sectors.
- Be alert and aware of one's surrounding

Question 7.2.1: What is the communication flow for critical information and real-time information during a disaster?

There were no replies for this question. Refer to state level.

Question 7.2.2: Do you maintain a dialogue with community leaders and community organisations?

Two organisations, Jabatan Kebajikan Masyarakat and Information Department Malaysia, maintain a dialogue with community leaders and community organisations.

Question 7.2.3: Do you have a mechanism for public participation or consultation regarding disaster mitigation?

Out of these two organisations, one of them has a mechanism for public participation or consultation regarding disaster mitigation.

Question 7.2.4: How is information on post-disaster relief and assistance communicated to the public?

According to the two above mentioned organisations, information on post-disaster relief and assistance are communicated to the public at the ministry level via news releases and media coverage.

Question 7.2.5: Is a media centre set up every time there is a disaster at the Federal, state, and district level?

The Media and Corporate Communication Division in the Information Department Malaysia sets up and manages the media centre in crisis management and communicating community assistance facilities.

Question 7.3.1: Have you aired or printed any public service announcements or public awareness programmes regarding landslide mitigation?

Five organisations have aired or printed some public service announcements or public awareness programmes. They are the Ministry of Science, Technology & Innovations, Radio Television Malaysia (RTM) and Bernama (National News Agency) and two other Government agencies.

Question 7.3.2: Have you received any feedback from the public on the effectiveness of the programmes?

Out of the five organisations, two have received feedback from the public on the effectiveness of the programmes, while another two did not receive any feedback. One organisation did not provide an answer.

Question 7.3.3: Is there an allocation in your oganisation's budget for developing public awareness and education programmes?

RTM has set some allocation in their Radio Interaction department some budget for developing public awareness and education programme. There was no listing of any percentage for the total budget.

Question 7.4.1: Do you think that public awareness and education programmes will mitigate the impact of landslides?

Only three organisations, Malaysian Centre for Remote Sensing (MACRES), the Ministry of Science, Technology & Innovation (MOSTI) and Universiti Teknologi Malaysia (UTM) Skudai stated that public awareness and education programmes will mitigate the impact of landslides.

Question 7.4.2: Do you have any landslide mitigation elements incorporated into your courses?

The Dean of highway engineering at UTM Skudai indicated that the school of civil engineering had landslide mitigation elements incorporated into their courses but did not provide any details.

Question 7.4.2: Do you have any landslide mitigation elements incorporated into your courses? If yes, do you have one on land use planning, land use design, landslide hazard, landslide hazard safety programmes, and community risk reduction?

UTM has indicated that they have material on all of the above items.

Question 7.5.1: Do you have any programmes created for the public information people what to do in the event of a slope disaster, either developed by your organisation or by a third party?

None of the organisations have any programmes created for the public informing people what to do in the event of a slope disaster.

Table 7.3: Listing of Federal agency respondents

	Federal Agencies
1	Atomic Energy Licensing Board
2	Board of Engineers Malaysia
3	Dept of Survey and Mapping Malaysia
4	Dept of Town and Country Planning
5	Information Department Malaysia
6	Jabatan Kebajikan Masyarakat
7	Jabatan Kerja Raya Malaysia
8	Jabatan Mineral dan Geosains
9	Jabatan Pengangkutan Jalan Wilayah (JPJ)
10	Jabatan Penilaian dan Perkhidmatan Harta
11	Jabatan Tanah dan Galian Persekutuan
12	JKT/KPKT
13	Malaysian Centre for Remote Sensing
14	Malaysian Highway Authority (MHA)
15	Malaysian Institute for Nuclear Technology Research
16	Malaysian Nature Society
17	Ministry of Education, Curriculum Development Centre
18	Ministry of Health
19	Ministry of Science, Technology, and Innovation
20	NatSeven TV Sdn. Bhd.
21	Radio Television Malaysia
22	Sistem Television Malaysia Berhad
23	Universiti of Malaysa
24	Universiti Teknologi Malaysia
25	Utusan Melayu (Malaysia) Berhad
26	Unidentified agency
27	Unidentifed agency

Questionnaire Feedback from State Agencies

There were 17 respondents among the state agencies. As per the following table, thirteen of the respondents were from the state agencies and four from the District Office/Town Council/Local Authority.

Table 7.4: Breakdown of respondents by category

N=17	Frequency
State Agencies	13
District Office/Town Council/City Hall	4
Total	17

Question 7.1.1: Do you have a public relations or public affairs department within your organisation?

Out of 17 respondents, only nine (53%) organisations have public relations within their organisation and three organisations and three (18%) do not have the public relations. Within these organisations, the Public Relationship Officer and customer care service units are responsible for the public relations function.

Question 7.1.2: Do you have an overall communication strategy?

Six organisations (35%) have an overall communication strategy while four organisations do not have and seven organisations (41%) did not answer the question. Out of the organisations that have the communication strategy, two have the stand alone strategy meanwhile four have plans that are inter-related to other agencies.

Question 7.1.3: Are there existing public disaster awareness programmes?

Seven organisations (41%) have a public disaster awareness programme. The programmes held were related to the firemen's role in rescuing public from landslide (*Jabatan Bomba dan Penyelamat Kelantan*), flood, tsunami/earthquake/heavy rain, public safety and assets and prevents outbreaks of diseases related to disasters.

Out of the awareness programmes, there were three that relates to slope disasters. They were organised by *Jabatan Bomba dan Penyelamat Kelantan*, Universiti Teknologi Malaysia in Johor and *Pejabat Jurutera Daerah* in Penang.

Question 7.1.4: Do you do the planning or implementation of the programmes or both?

Five organisations do the planning or implementation of the programmes.

Question 7.1.5: How successful were the disaster awareness programmes?

The success of each programme varies, but in most cases, the programmes were successful in increasing the public's awareness on the disaster.

Question 7.1.6: What do you think are the key success factors of such programmes?

There were no replies to this question.

Question 7.1.7: What form of media did you use to convey the awareness messages?

The table below shows frequency of the media used by the organisations to convey the awareness messages.

Table 7.5: Types of media used

Media	**Frequency**
Television	**4**
Radio	**4**
Static displays (posters)	**3**
Exhibits and road show	**4**
Print	**6**
Internet	**4**
Others	**0**

Among the state agencies, print format (24%) was the widely used medium for disseminating awareness messages. In addition, phone, e-mail, letters, website hits and interactive Q&A were also implemented by Sarawak Health Department.

Question 7.1.8: How is feedback information on the programmes relayed to you?

Majlis Perbandaran Sandakan, which used the print medium, stated that there was the poor performance of the programme. The rest reported none.

Question 7.1.9: What key messages to the public has your organisation conveyed in the area of landslide mitigation?

There were no replies to this question.

Question 7.2.1: What is the communication flow for critical information and real-time information during a disaster?

According to the National Security Division, the communication flow for critical and real-time information during a disaster starts "almost immediately". For state-level disasters, dissemination begins as soon as critical information on the disaster has been approved for release by the National Disaster Management Committee Chairman/Secretariat and the State Office of Tanah dan Galian in accordance to Directive No. 20, "Planning and Mechanism for Emergency Management and Relief".

Question 7.2.2: Do you maintain a dialogue with community leaders and community organisations?

Two organisations, Information Department Malaysia and *Pejabat Tanah dan Galian Negeri* maintain dialogues with community leaders and community organisations. However, both organisations do not have any mechanism for public participation or consultation regarding disaster mitigation. Only *Jabatan Alam Sekitar Pulau Pinang* has a detailed EIA report for public participation or consultation regarding disaster mitigation.

Question 7.2.3: Do you have a mechanism for public participation or consultation regarding disaster mitigation?

Jabatan Alam Sekitar Pulau Pinang reported that it releases Environmental Impact Assessments for public viewing.

Question 7.2.4: How is information on post-disaster relief and assistance communicated to the public?

Pejabat Tanah dan Galian reported that the information on post-disaster relief and assistance were communicated to the public via news releases and media coverage and through committee members of flood management.

Question 7.2.5: Is a media centre set up every time there is a disaster at the Federal, state, and district level?

Pejabat Tanah dan Galian noted that a media centre is set up every time there is a disaster at the Federal, state and district level. The National Security Division and the State Government are responsible for managing the media centre at the state level

Question 7.3.1: Have you aired or printed any public service announcements or public awareness programmes regarding landslide mitigation?

There were no replies to this question.

Question 7.3.2: Have you received any feedback from the public on the effectiveness of the programmes?

There were no replies to this question.

Question 7.3.3: Is there an allocation in your organisation's budget for developing public awareness and education programmes?

Pejabat Tanah dan Galian Negeri has set some budget for developing public awareness and education programme. There is no listing of any percentage for the total budget.

Question 7.4.1: Do you think that public awareness and education programmes will mitigate the impact of landslides?

There were no replies to this question.

Question 7.4.2: Do you have any landslide mitigation elements incorporated into your courses?

UTM Skudai, which has the landslide mitigation elements incorporated into their courses, stated that public awareness and education programmes will mitigate the impact of landslides. Institution of Engineers Malaysia Sabah (IEM Sabah) has also organised landslide mitigation or similar courses/seminar at least once annually to provide education/training and awareness to members.

IEM Sabah stated that they have education programme on land use design, landslide hazard, and landslide hazard safety programmes. UTM Skudai also has the education programme on landslide mitigation and all the items.

Question 7.5.1: Do you have any programmes created for the public information people what to do in the event of a slope disaster, either developed by your organisation or by a third party?

Sarawak Health Department noted that they have any programmes created for the public informing people what to do in the event of a slope disaster only if public has to be relocated in temporary shelters. They have messages related to hygiene, food safety, and prevention of food and waterborne diseases targeted to displaced persons in temporary shelters.

Table 7.6: Listing of state agency respondents

	Agency
1	Institute of Engineers Malaysia Sabah
2	Jabatan Alam Sekitar Pulau Pinang
3	Jabatan Bomba dan Penyelamat Kelantan
4	Jabatan Bomba dan Penyelamat Pulau Pinang
5	Jabatan Kebajikan Masyarakat Selangor
6	Jabatan Kesihatan Selangor
7	Jabatan Meteorologi Malaysia Kuching
8	Jabatan Tanah dan Galian
9	Majlis Daerah Pekan
10	Majlis Daerat Tapah
11	Majlis Perbandaran Kota Baru
12	Majlis Perbandaran Sandakan
13	National Disaster Management and Relief
14	Pejabat Jurutera Daerah
15	Pejabat Tanah dan Galian Malaysia
16	Polis Di Raja Kelantan
17	Sarawak Health Department

Preliminary Findings to the Questionnaires and Interviews

There are some inherent difficulties in interpreting the questionnaire results for the following reasons:

- Variance in respondent profile: The questionnaires were sent out to the directors of the Government agencies. However, position and designation of the respondent actually filling out the questionnaire varied from director to technical engineers. This gave an imbalanced set of replies as some of the respondents lacked the high-level perspective needed to answer the questions.
- Willingness to allocate time: It appears that a number of agencies had started to fill out the questionnaire, but after a few questions, they left the rest of the questionnaire blank. In extreme cases, only the company and respondent particulars page were filled out or website pages stapled to an otherwise blank questionnaire. This happened with agencies that received a set of questionnaires from more than one component. The low rate of complete questionnaires could be attributed to the level of respondents' willingness to spend time on this questionnaire. The Study Group conducted a testing of the questionnaire with regards to time: a control subject said it took an average of 20 minutes to fill out the 3-page questionnaire per component.

- Perceived difficulty: Some of the respondents appeared intimidated by the questionnaires, claiming it was "too technical" or that they were not civil engineers. This happened in cases were the PAE Component's questionnaire was sent with those of the other components. This claim cannot be validated as there was no usability test conducted on the questionnaires prior to dissemination.

APPENDIX 1 (B): Methodology for Deriving Strategies

When formulating public awareness and education plans, care should be taken to ensure that it does not comprise solely of programme development and execution, such as conducting workshops and holding seminars. While these are undoubtedly effective tools for conveying critical knowledge, public education - as emphasised by Emergency Management Australia (EMA) - constitutes more than just the printing and dissemination of brochures.

Rather, it is a culmination of four elements: (1) the external messages and methods to be deployed in delivering risk reduction information to target audiences; (2) the messenger's capacity to follow through on its mandate and vision; (3) a clear understanding of the target audiences' information needs, preferences, and resistance in adopting prescribed measures; and (4) the co-ordinated release of Agency programmes.

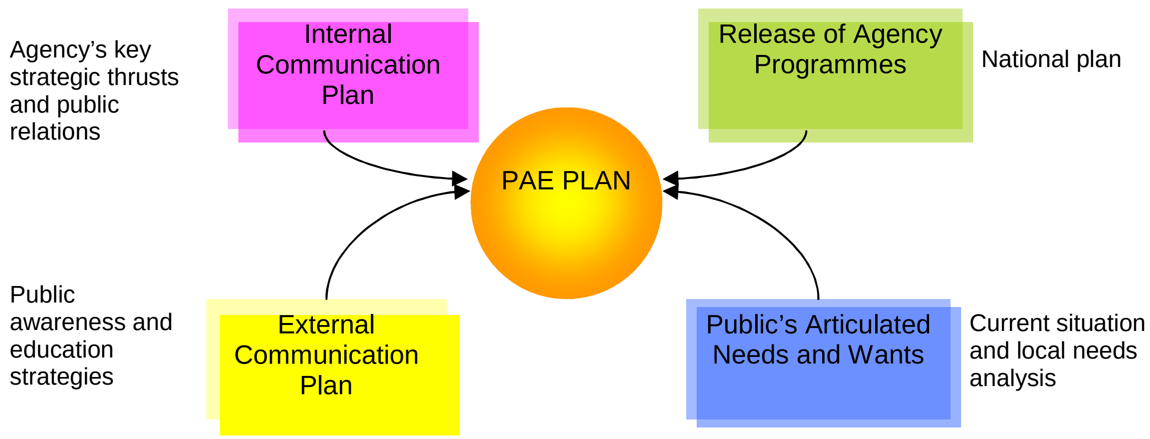


Figure 7.1: Four facets of a public awareness and education plan

This approach has been promoted in Macedonia's "Environmental Awareness Strategy: Technical Report", which is a European Union-funded project managed by the European Agency for Reconstruction. Guided by the Acquis Communautaire (a pan-European basis for policy design), the plan combines internal and external communication and public relations strategies.

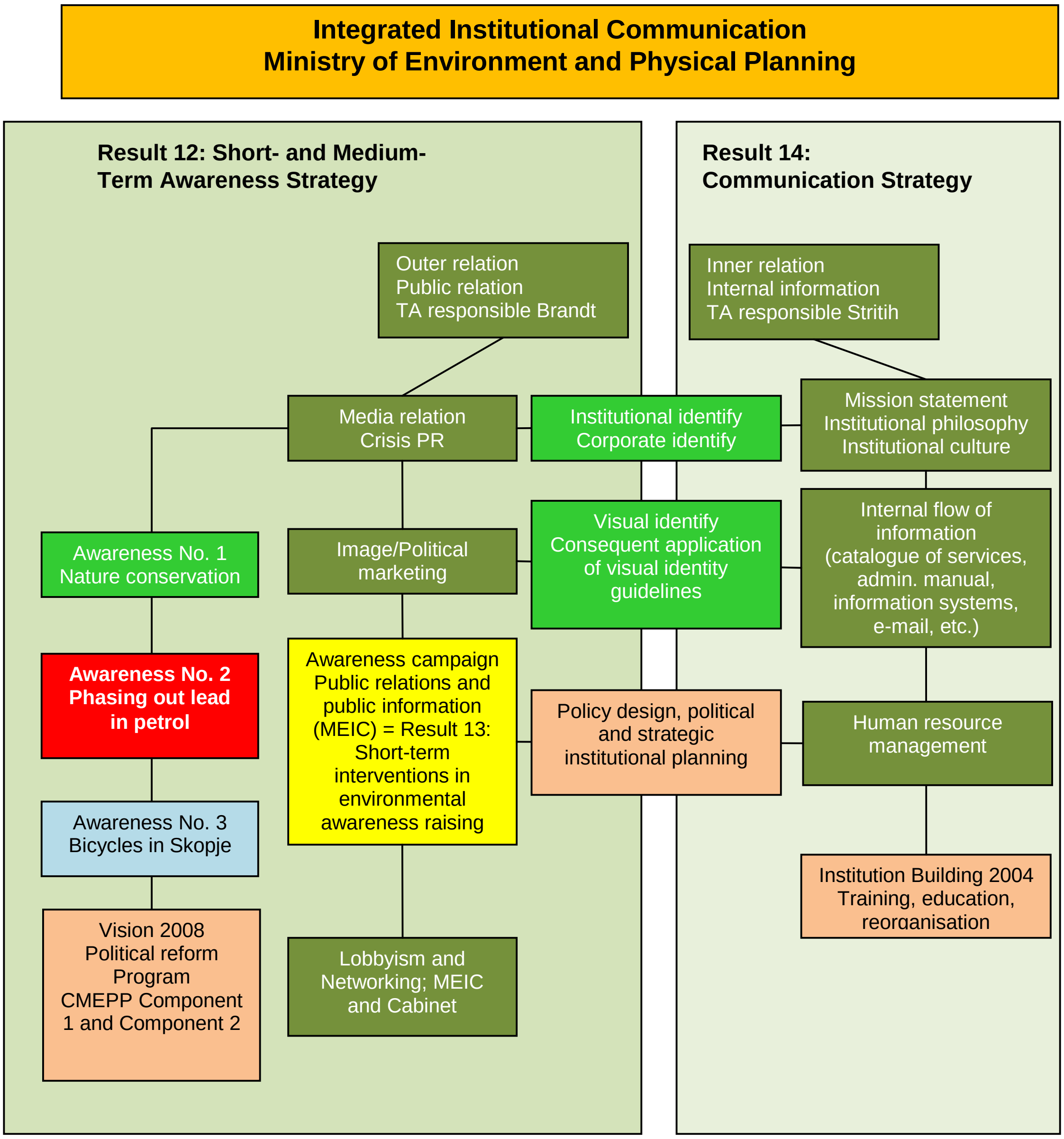


Figure 7.2: Vision 2008 and Applied Strategy (Macedonia's Ministry of Environment and Physical Planning)

Using terms such as "mother strategy" and "daughter strategies," the Environmental Awareness planners rationalised that the Ministry's basic strategy should form the foundation of all awareness and promotion activities. This is because in addition to providing environmental education content, the programmes would serve to communicate policies that will be introduced by the Agency to stakeholders in the Government, NGOs, private sectors, and the public.

In a similar manner, the different strategic thrusts of Hong Kong's Geotechnical Engineering Office (GEO) have led to the deployment of strategy-specific programmes. In Malaysia's Slope Agency, key strategic directions are shown in Figure 7.17: Projected functions of the Agency.

8. LOSS REDUCTION MEASURES

8. LOSS REDUCTION MEASURES

8.1 Overview

The component for loss reduction measures will address the necessary measures required to be adopted in slope engineering works to prevent or minimise the occurrence of landslides and loss of life.

8.1.1. Introduction to Loss Reduction Measures

Recent landslide events have the adverse effects on the human population and economy of the country. Despite advances in science and technology, these events continue to result in human suffering, millions in property losses, and environment degradation. It is expected that with continuous population increase and economic development the economic and societal costs of landslides will continue to rise. Hence there is a need for a comprehensive programme to reduce landslide losses by introducing Loss Reduction and Preventive Measures to all levels of government and private sector. Landslide loss reduction and preventive measures should be taken in geographical areas facing landslide problems. State and local governments can prevent or reduce landslide losses through early warning and monitoring system, better policy and effective implementation, design procedures, local hazard mapping, land use management, building and grading controls.

8.1.2. Objective of Loss Reduction Measures

The objective of loss reduction measures is to develop appropriate mitigation measures in order to eliminate or minimise losses to life and property due to landslide. In order to meet the objective, this component shall:

- Evaluate various impediments or effective planning, design, construction and maintenance on development with respect to landslide hazard reduction, and identify approaches for removing those impediments.
- Develop a national plan to improve planning, design, construction, maintenance and preventive approaches to reduce losses due to landslides.

- Develop a framework of guidelines on planning, design, construction and maintenance of slopes to reduce risk from landslides.
- Develop educational programmes for federal, state and local authorities that emphasize the risk and costs of landslide hazards.
- Propose a framework of incentives and disincentives for encouraging landslide mitigation to government agencies, private sector and academia.
- Develop a national plan to adopt landslide mitigation technologies as part of Landslide Preventive Measures.

8.2 Problem Statement

In the course of carrying out the study, numerous processes and measures were required to confirm and establish facts. This involved the process of developing questionnaires, conducting surveys and interviews with various stakeholders and government agencies at state and federal levels, literature reviews and references on the related subjects. Difficulties arose getting successful feedback and required data from this exercise . Due to the paucity of feedback, facts and figures from the limited feedback were extracted to make assumptions and formulate strategies. However, getting feedback from Malaysian sources, however limited, is doomed much more valuable than using data from experience taken in other counting.

The study will also be overlapping with topics covered by other components of this study. Accordingly, appropriate interfacing will involve Policies and Institutional Framework (PIF), Hazard Mapping and Assessment (HMA), Early Warning and Real Time Monitoring System (EWS), Information Collection, Interpretation, Dissemination and Archiving (ICIDA), Training (TRN) and Research and Development (R&D). Appropriate methods were employed to adopt, share incorporate and improve the findings of the other components and incorporate them into a cohesive structure for final presentation and recommendation.

8.2.1 Current Situation

At present, the impediments to effective slope management in Malaysia are summarised as follows:

- The existing loss reduction measures for landslides are mostly done on an ad-hoc basis and there is a lack of systematic planning. This is mainly due to the low awareness of risk and hazard management, environmental concerns and social impacts in mitigating landslides. Currently there is no lead agency to monitor and address landslide events, and this consequently obscures the focus and direction of landslide prevention and mitigation measures.
- Loss reduction measures take many forms, with land use regulation being a primary factor in development approval. The existing land use regulations as identified under Policies and Institutional Framework (PIF) nighlight various factors to be considered, one of them being the approval of hill land development based on slope gradients. Some of the risk categorizations are implemented in a simple approach, which lead to the hill land development to be lack of enforcement control, monitoring, maintenance and preventive measures.
- The irrigation, runoff and drainage system of temporary slopes during the construction stage generally are properly addressed. The overflow and debris problems are frequently observed at sites after heavy rainfall. Proper and adequate control of surface and groundwater drainage must be considered for effective slope stabilisation
- Maintenance of existing slopes is always neglected. In some cases small erosion may lead to a disastrous landslide if the problem is not rectified from the beginning and allowed to persist for long periods.
- The existing design of untreated or treated cut and filled slopes are generally prescribed using JKR's specifications. The current technical evaluation needs to be expanded in depth, such that the resulting criteria can be applied to fit the particular design and construction needs.

- Well-planned hillside development requires the input of geotechnical experts which at present is to be limited or not considered at all, and the state and local authorities are ill-equipped to effectively vet through the development applications.
- The failure mechanisms of historical landslides and triggering factors have not been fully understood. The root causes and types of landslides required to be undertaken as a R&D task in order to create Malaysian standards and approaches in landslide prevention technology.

8.2.2 SWOT Analysis

It is clear from the flow process as presented, that for the application of a standard development, particularly those that involve hillside or sloping terrains, potential shortcomings and impediments could arise within agencies or departments responsible for such tasks.

This is because proper vetting of the submissions involves a sound knowledge of the engineering involved and a thorough understanding and appreciation of the inherent risks and hazards associated with such developments. Lacking in any of these would translate into weak and incompetent enforcement.

In this regard, a full review and revision of the current approval and enforcement processes is necessary in order to include developments involving hillsides and sloping terrains. Of equal importance is the level of competency demonstrated by the submitting engineer for such developments, who must not only be upgraded but constantly trained to keep in line with the latest technology and good engineering practices.

An overall tightening in procedures from both the submitting and approving parties is therefore relevant and necessary.

Accordingly, the proposed strategy will need to take into consideration and address the following:

i) Planning Approval

a. The current checklist of information, such as type of terrain and land use, adequate and appropriate geotechnical investigation and design, and hydro-geological study, to be furnished at the planning stage for hillside development may be inadequate. Hence improvement and upgrading is necessary.

b. The experience of the submitting, as well as the approving, engineer in handling projects of this nature may be lacking and this also needs to be enhanced and upgraded.

c. Land use planning and procedures to be complied with under various Acts, (e.g., National Land Code, Town and Country Planning Act, Local Government Act, Street Drainage and Building Act, Land Conservation Act, Environmental Quality Act and Earthworks By-laws need to be revamped, to include updated policies governing hillside developments

d. Submission and approval processes need to be standardised and streamlined for better delivery.

ii) Design Quality, Submission and Acceptance

a. The standards and procedures of design dealing specifically with hillside development and slope engineering in particular, may be inadequate both from the engineers' side and from the approving authority's side, could be due to a lack of understanding of the mechanics and engineering involved. It is imperative that such shortcomings are duly addressed by drawing up standard design procedures and guidelines which will include but is not limited to :

- a better understanding of the fundamentals of slope engineering,
- the relevant and necessary geotechnical/hydro-geological investigation requirements,
- the correct usage of design approach, and
- an overall appreciation and understanding of hillside development and its impact on the surrounding environment with respect to safety and hazards.

This must be understand by all submitting parties (professionals practitioners, – contractors, developers and landowners) and approving agencies (local authorities, government departments and agencies) to adopt.

b. The usual documentation for development plan submission as often submitted by the civil and structural consultants will not be adequate when dealing with hillside or sloping terrains. Additional requirements in respect to supporting documents such as soil investigation and geotechnical reports and will become necessary and should be introduced as a permanent and compulsory accompaniment to the development plan. This will ensure that the submitted design complies with the minimum standards required of developments of such nature. This applies similarly to the use of specific standards, which must be relevant to geotechnical engineering (such as slope treatment/ stabilisation, retaining structures, foundation and drainage systems) and on par with those adopted internationally

c. The approving authorities and various related agencies that have been entrusted to assess, review and comment on the development submissions may not possess the necessary manpower, resources and expertise to manage and check the design plans and recommendations for accuracy and adequacy. This is an impediment plaguing the current education, joint cooperation/research with academia or foreign established institutions and agencies, and recruitment of manpower and expertise.

iii) Construction

a. The terms of the submitting engineer's engagement by the client or stakeholder may force the Engineer (through financial pressure / constraint) to compromise on the need for maintaining adequate supervision during construction. Nevertheless, this factor should not preclude engineers from executing the obligations and functions as required under the relevant Acts (eg., the Uniform Building By-Laws). Failure to appreciate this is not an excuse for engineers to get involved or undertake the supervision. The emergence of new rules or refinement of existing policies governing this matter will assist in circumvent these shortcomings.

b. There is the likelihood that the submitting engineer may be from within the client's or stakeholder's own organisation such that a conflict of interest may result. Updating of policies governing this will prevent such occurrences.

c. The engineers involved simply lacks the experience and expertise to deal with this line of work. Guidelines to specify the requirement for a qualified professional to ensure responsibility and integrity is needed;

d. As with planning and design, the client or stakeholder may exert certain influence through weaknesses in the system and exploit the situation to bypass certain construction requirements to achieve the objectives (i.e., maximise profit). A strong and disciplined form of governance on part of the approving agency, coupled with compulsory adherence to detailed guidelines, will ensure safety is not compromised.

e. Similarly, the apparent lack of manpower, resources and expertise of the approving authority to monitor progress and carry out enforcements will have to be improved to ensure that adequate safety checks are carried out and appropriate recommendations for safety improvements in design and construction are meted out.

iv) Maintenance

a. Lack of enforcement on the part of the approving authorities in compelling the developer to adopt the minimum safety and maintenance procedures associated with such works will have to be overcome. Likewise, a lack of appreciation on the part of the submitting engineer to the importance and necessity of good and proper slope maintenance, which should be recognised as an integral part of slope engineering and design work, should be discouraged by the enforcement maintenance guidelines and such must be made compulsory.

b. The existing procedures dealing with such works do not address the importance and necessity of proper and adequate maintenance, thereby leaving the matter to the often biased interpretation of the submitting engineer or the client / stakeholder. It is imperative that this situation does not arise by meting out guidelines (even procedures) which makes it compulsory for maintenance of slopes and slope related developments to be a relevant part ongoing and post-construction programme

c. The client/stakeholder has the overriding tendency to ignore existing rulings governing proper slope maintenance through sheer influence and/or loopholes that may be inherent in the system. This problem can be overcome by removing such loopholes and tightening the delivery system through stringent guidelines and policy enforcement.

v) Landslide Preventive Measures

a. Landslide Preventive Measures (LPMs) must be incorporated into a long -term programme to rectify substandard government and manage private man-made slopes. Under the programme, slopes required to be studied in detail in terms of the risk posed to the community and the possible fatalities caused by slope failures.

b. systematic approach is required to catalogue the slopes that are found to be substandard for both government and private man-made slope.

c. LPMs are required to be included in preliminary and detailed studies in the design of slopes that require rectification and in the mode of execution taking into consideration engineering, social and financial aspects.

8.2.3 Needs and Constraints

The following identifies the needs towards improving loss reduction measures. and thus form the bases for the formulation and implementation of a national plan and framework on loss reduction measures:

i. Standardisation of practice and formulation of relevant guidelines

ii. Education and empowerment for practitioners in the private as well as public sectors, with sound engineering knowledge and technical know-how to undertake and execute responsibilities effectively

iii. Adoption of current/best practices and standards, which need to be updated from time to time to be on par with international standards

iv. Keeping abreast of the latest technologies in slope engineering

v. Making available funding (allocation from the National Budget) for monitoring and maintenance works

vi. Increasing human resource and hiring of right people for the job

vii. Cutting irrelevant and unnecessary bureaucracy and red tape to improve the government machinery and delivery system

viii. Setting-up of a National Slope Engineering Agency (SEA) as the sole managing and approving agency for all hillside developments so that this will become an independent entity which will be completely free from outside influence to carry out its duties and responsibilities effectively and efficiently. Such a centre (which subsequently could be advanced into a centre of excellence for slope engineering, can come under the purview of JKR

ix. Possession of political will to empower the above slope agency to perform its duty effectively

8.3 Detailed Study

The study to formulate a loss reduction measure framework included the following activities :

i) Study and recommend improvements on national development approval processes

ii) Study and propose the following :

   a. The involvement of SEA at various stages of the development process
   b. Development of a legal framework as part of loss reduction measures
   c. Loss reduction measures during the design stage
   d. Loss reduction measures during the construction stage
   e. Loss reduction by enhancing maintenance, management and monitoring works
   f. Adoption of LPMs to reduce losses in the long-term
   g. Develop educational programmes for federal, state and local authorities on landslide hazards
   h. Propose framework of incentive and disincentive schemes
   i. Develop a national plan for landslide mitigation technologies

8.3.1 Evaluate Existing Impediments for Effective Slope Engineering Development

To evaluate the existing impediments, the general processes involved in the development and implementation of a typical project needs to be studied. It is necessary to refer to and understand the procedures involved in applying and obtaining approvals from the local authority in order to trace the occurrence of impediments, from planning to design to construction and finally during maintenance stage of a typical project implementation. This will include the handing over and maintenance of abandoned slopes, as part of Loss Reduction Measures (LRM) and Landslide Preventive Measures (LPM).

The Federal Territory (Planning) Act, 1982, requires all landowners to secure planning permission prior to construction of any building or structure or change of land use or building use. The main function of the Planning and Building Control Department is to process applications for planning permission. As such, the Act provides that no person shall commence, undertake or carry out any development, irrespective of whether or not the development is in conformity with the development plans, unless the development order granting the planning permission in respect of such development has been issued (Section 20(1) Act 267).

Generally there are two types of planning applications involved, namely:

i. Application for land subdivision and land use zoning (layout plan); and
ii. Application for erection of building.

The administrative setup for considering planning applications is in turn divided into three categories :

i. Town Planning Committee I (TPC I)
ii. Town Planning Committee II (TPC II)
iii. Town Planning Committee III (TPC III)

In summary, the scope of responsibilities under TPC I include the formulation of policies and evaluation of large scale development such as:

i. Subdivision and amalgamation (Layout Plan application)
ii. Change of land use zoning
iii. Change of density zoning
iv. Large-scale and comprehensive development
v. High-intensity development
vi. Government/privatisation project
vii. Development in conservation area
viii. Large-scale infrastructure and facilities project
ix. Change of building usage in city centre

Those of TPC II include the consideration of straightforward planning application to comply with planning policies and guidelines such as:

i. Medium-scale development application
ii. Small-scale infrastructure/facilities projects
iii. Change of building usage outside city centre
iv. Addition and alteration to commercial, industrial and institutional buildings

And TPC III is involved in the consideration of minor application to ensure compliance with planning policies and guidelines such as:

i. Small scale development application
ii. Addition and alteration to bungalow, semi detached and terrace houses on flat land
iii. Extension of Development Order

Upon submission, the application will have to go through planning evaluation which ensures compliance with:

i. Statutory provisions
ii. Policies and planning guidelines
iii. Technical criteria
iv. Other relevant considerations

The statutory provisions include:

i. Federal Territory (Planning) Act1982, Act 267
ii. Comprehensive Development Plan (population density CDP 1040 and land use CDP 1041)
iii. Local Government Act 1972, Act 171
iv. Road, Drainage and Building Act 1974, Act 133
v. Kuala Lumpur Federal Territory Building By-Law 1985

vi. Rules made under the provisions of the Planning :

a. Submission Planning Application Rules 1970

b. Development Charge Rules 1982

c. Use Class Rules 1985

d. Zoning and Density Rules 1985

Policies and development guidelines include the following:

i. Kuala Lumpur Structure Plan policies
ii. Federal Government development policies
iii. Cabinet directives
iv. Ministry and government agencies guidelines
v. TPC planning policies
vi. Policies which apply to specific areas

For technical criteria, emphasis will be placed on the following considerations:

i. Land use and residential density
ii. Plot ratio, plinth area and setback
iii. Topography, slope and land cut
iv. Building design
v. Infrastructure improvement and upgrading
vi. Accessibility
vii. Provision for public utilities and facilities, educational and religion
viii. Landscape and recreation area requirement
ix. Circulation system and provision of car parking space

Other considerations include

i. Approval at layout stage
ii. Case by case history of planning decisions
iii. Merit of objections of the neighbouring owner

The overall flow process can best be illustrated by the following pictograms and flowcharts, in **Figure 8.1** and **8.2** respectively

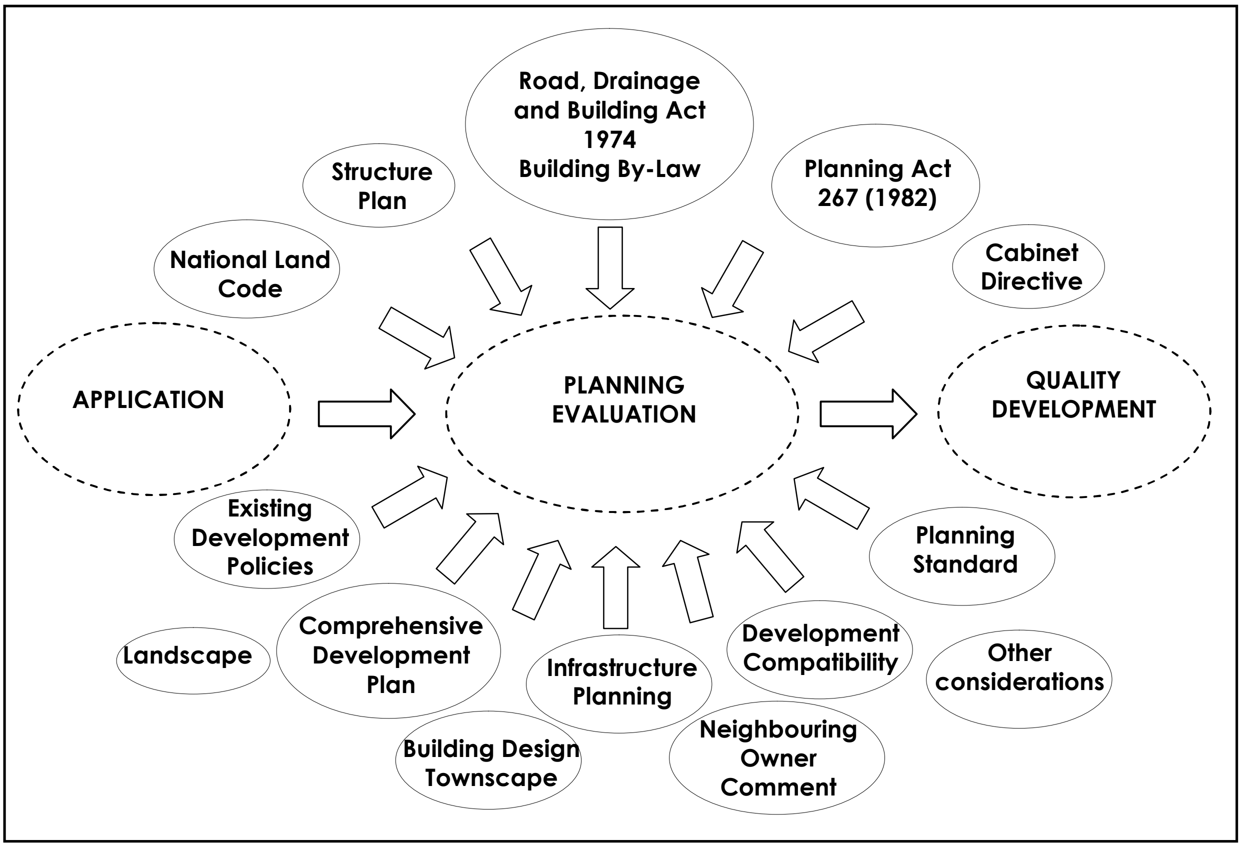


Figure 8.1: Planning evaluation criteria

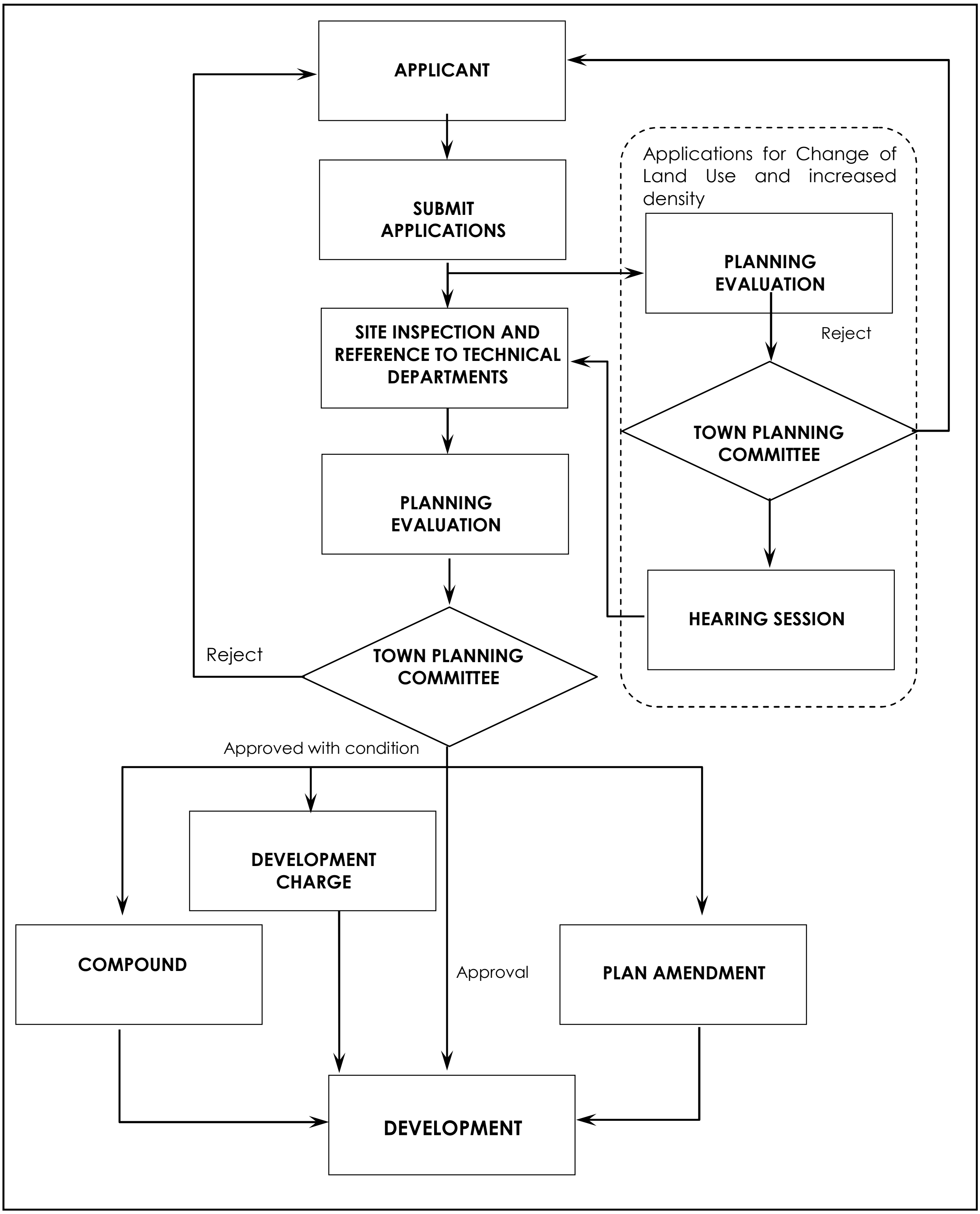


Figure 8.2: Planning permission approval process

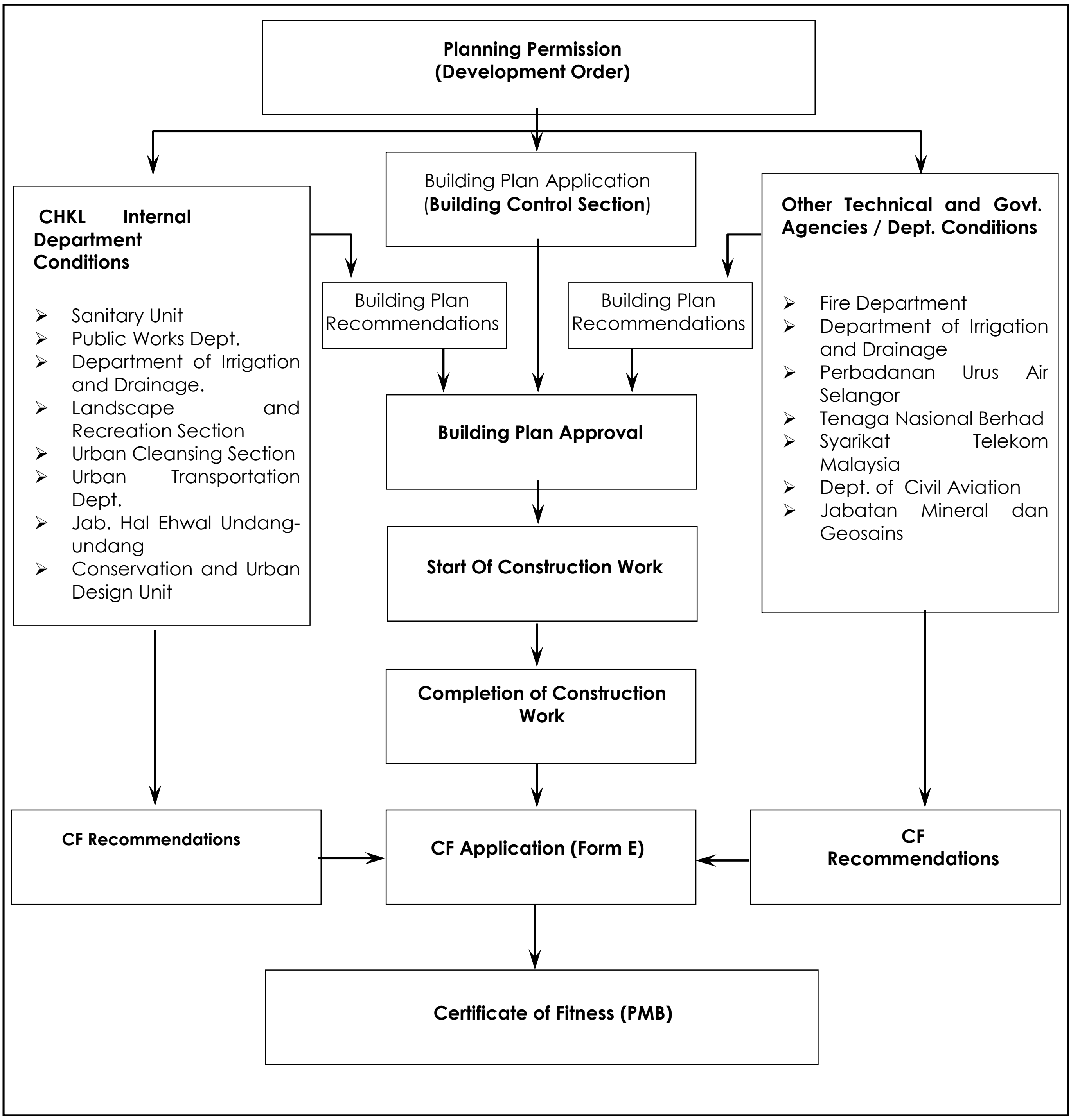


Figure 8.3: Planning permission approval process

In the above flow chart **Figure 8.3,** the conditions attached to the approval process of the development order are governed by various guidelines and the approval to be obtained from the building control section. The primary function of the building control is to ensure that the buildings are erected in accordance with specifications and regulations under the Building By-Law, which are:

i. Compliance to Approved Plan and Development Order conditions,
ii. Compliance to Planning Act and Building By-Law,
iii. Compliance to policies and guidelines and
iv. Approval and endorsement from the relevant technical departments.

More importantly, the control and monitoring of construction upon obtaining approval need to be emphasised to:

i. Ensure the safety and cleanliness of construction site;
ii. Monitor progress of work at every stage of the construction work;
iii. Ensure construction work progress according to approved building plans;
iv. Ensure hoarding in construction site is in good condition;
v. Ensuring building set back does not exceed the minimum requirement; and
vi. Take action on any complaints and nuisance reported.

8.3.2 Develop a National Plan for Improvement on Loss Reduction

In order to develop a national plan for improvement on loss reduction measures, study and interviews were conducted with local and other relevant authorities. From the survey it was found that it was desirable to take preventive measures at the early stages of the a development process. Hence it is proposed to incorporate loss reduction measures at various levels of development process.

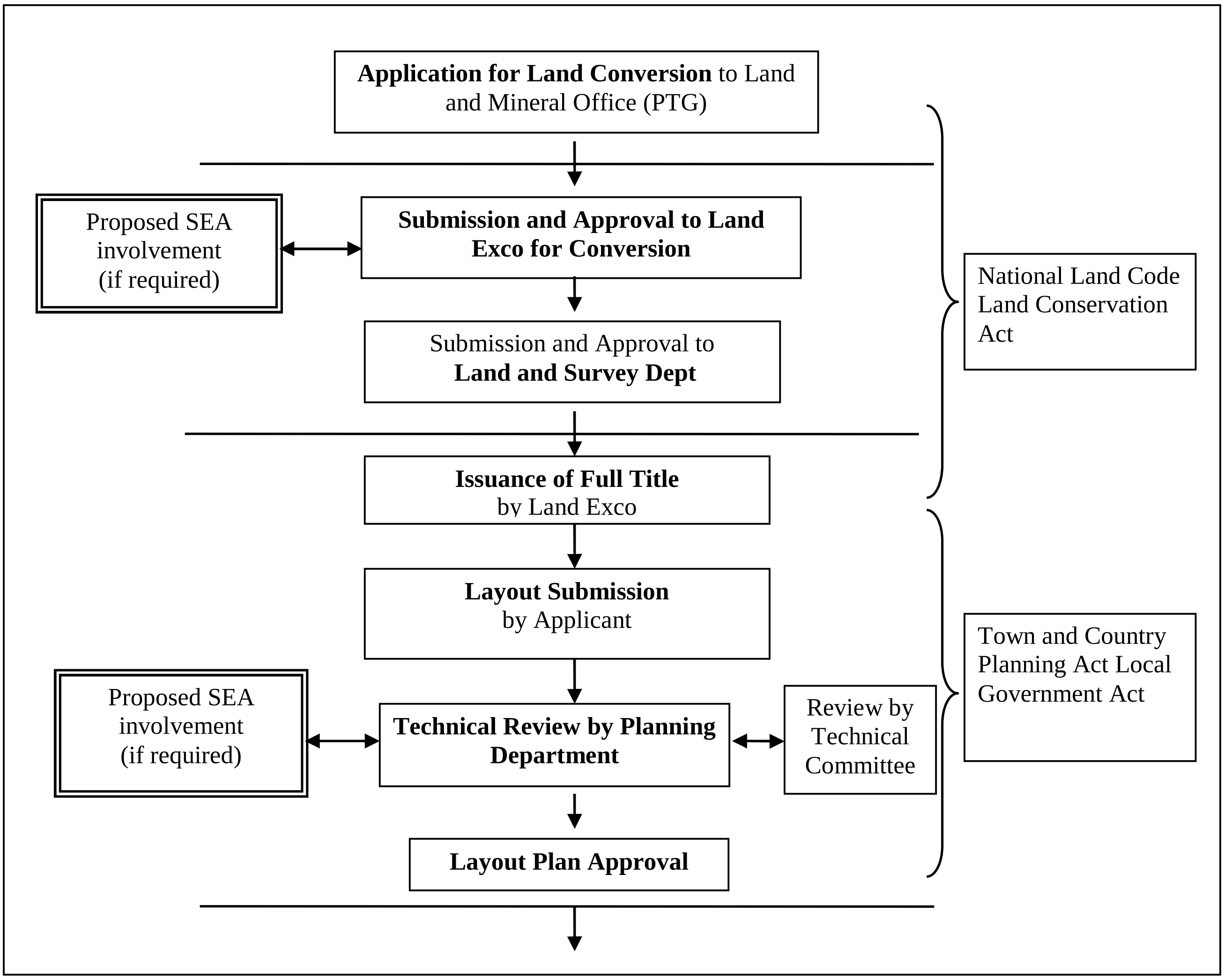


Figure 8.4 Current development approval process with proposed involvement of SEA

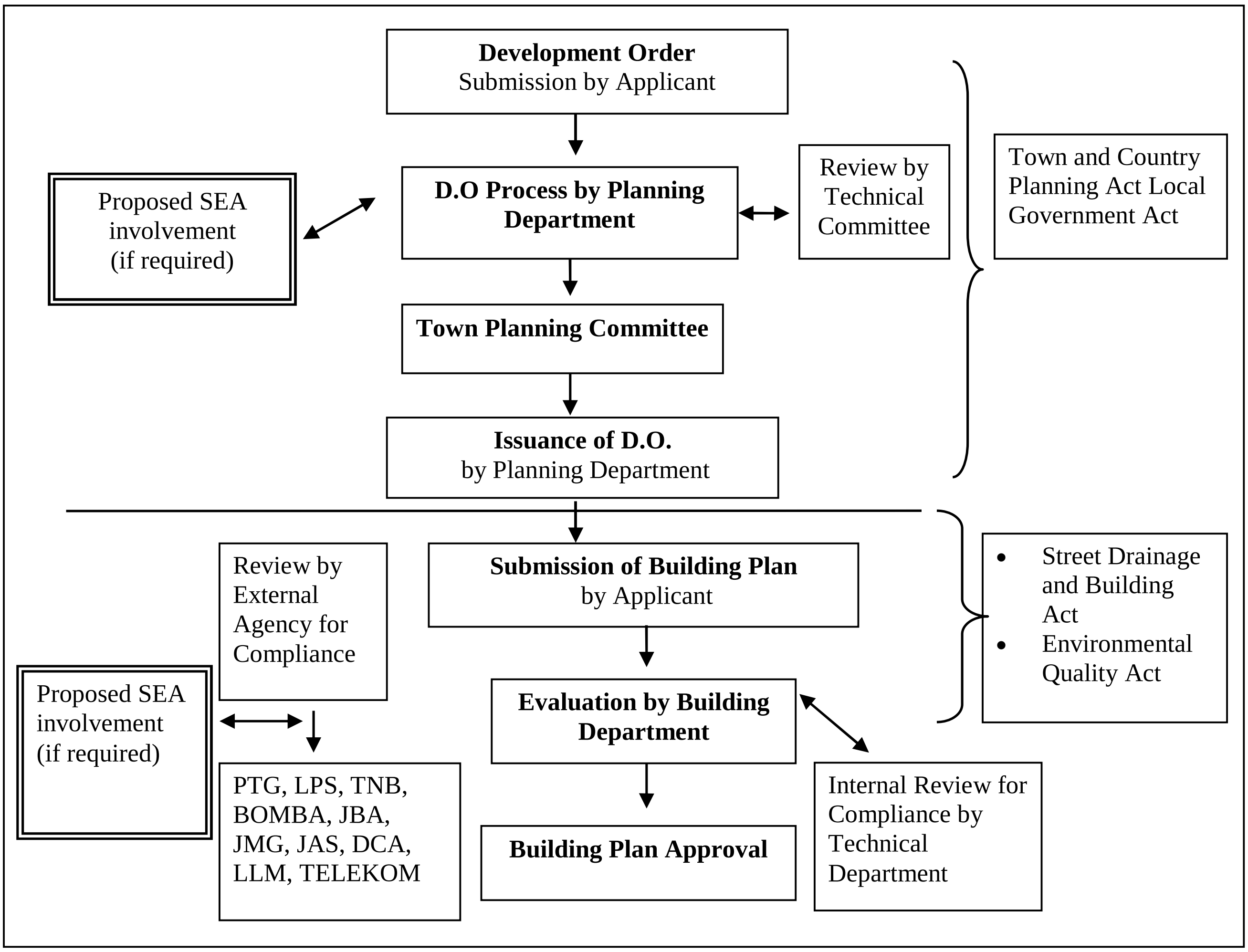


Figure 8.4 Current Development Approval Process with Proposed Involvement of SEA (continued)

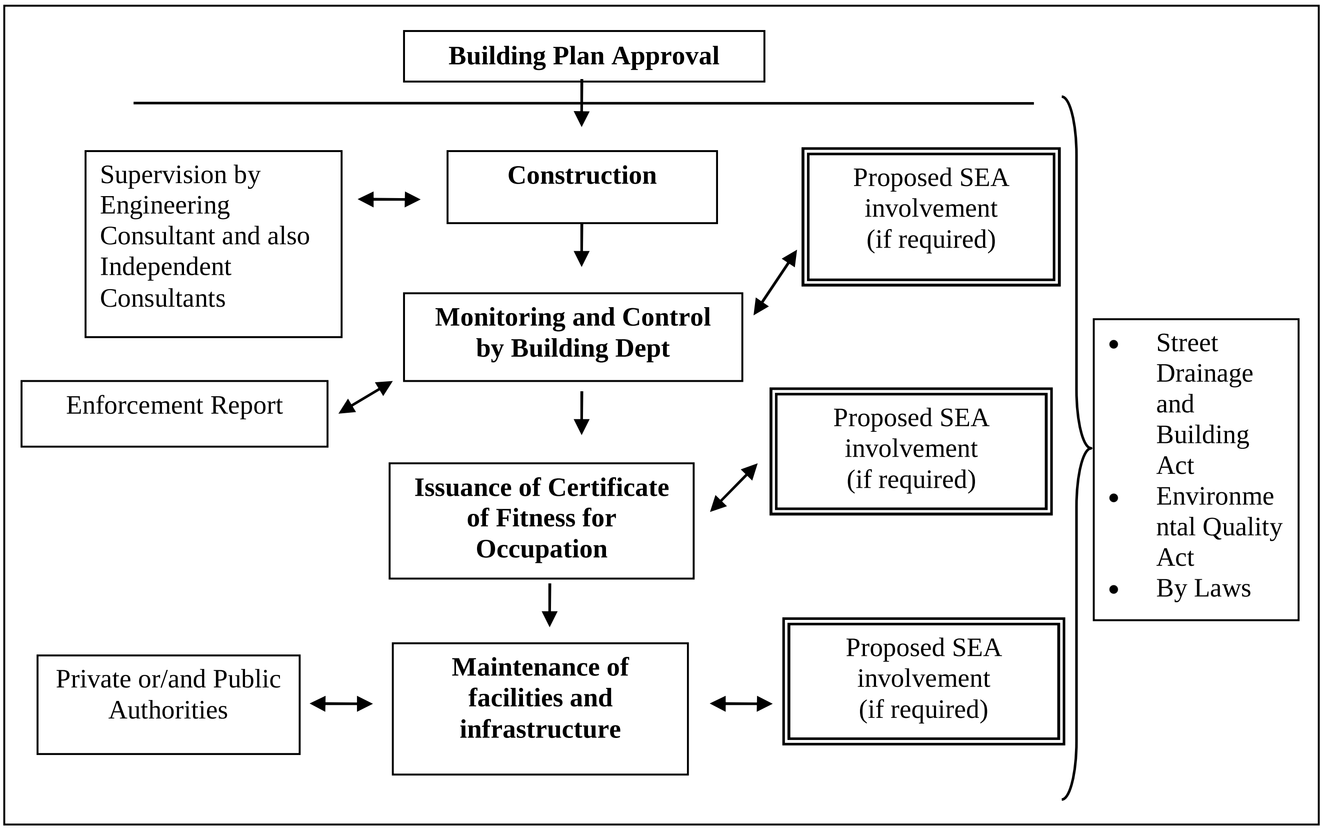


Figure 8.4 Current Development Approval Process with Proposed Involvement of SEA (continue)

Figure 8.4 shows the current development approval process with proposed involvement of SEA at various stages. The involvement of SEA is proposed to be at the following stages :

1. During the submission and approval to land Exco for conversion under legislation of National Land Code and Land Conservation Act
2. During the technical review by Planning Department, under the Town and County Planning Act and Local Government Act
3. During the D.O. process by Planning Department under the Town and Country Planning Act and Local Government Act
4. During the submission of building plan by applicant, evaluation by building department, construction stage, issuance of certificate of fitness for occupation and finally maintenance of facilities and infrastructure under the National land code and land conservation

SEA's involvement would enhance the decision making capacity of the local authorities.

8.3.3 Development of Legal Framework as Part of Loss Reduction Measures

In order to formulate a feasible legal framework loss reduction measures, the process flow of land development such as planning, application, approval, design, construction and maintenances need to be identified and fine. Hence, loss reduction measures need to be taken into consideration at every stage of development. This section will discuss the important factors that need to be taken into consideration at various stages of development:

i. Loss reduction measures within the current legal frame work
ii. Loss reduction measures during development planning stage
iii. Loss reduction measures during design stage
iv. Loss reduction measures during construction stage
v. Loss reduction measures by enhancing maintenance, management and monitoring of slopes

Long-term loss reduction measures by adopting LPM

8.3.3.1 Loss Reduction Measures within the Current Legal Frame Work

There are several laws which contain provisions for the protection of hill land development which has some loss reduction measures:

i) National Land Code 1965

The code contains provisions for dealing with hill land. As land is the property of the State, the authority has the right to reserve land for any public purpose which cannot be alienated by notification in the Gazette. As such, the State Government can set aside hill land as reserved land, "catchment land" or "forest reserves", impose appropriate conditions for land conversion and thereby protecting such land from being developed. This code can be applied if the proposed development is found to be located on high risk hilly terrain.

ii) Conservation Act 1960 (Revised 1989)

The conservation act gazettes hilly land as "hill land". Hilly land is not specifically defined but to all intents and purposes, it is interpreted to mean hill areas with steep slopes. The act has many sections which provide for the protection of hill land from development, especially in relation to soil erosion. However, its definition of the term "hill land" is loose and is open for misinterpretation or abuse. Under the act, any land within the State may be declared as hill land by the Ruler in Council or the Yang Di-Pertua Negeri in Council of a State by notification in the Gazette. As such, it is entirely up to the State to decide on what constitutes hill land and what does not. If the State has a loose definition, or has none, then the consequences would be disastrous as developers would capitalize on the loose definition by developing the hills. Hence it is proposed for all states to carry out hazard mapping to identify those hazardous areas and gazette them if required. It would also be necessary introduce control development on hazardous areas.

iii) The Land Acquisition Act 1960

This act provides for the acquisition of hill land whenever it appears desirable to the Ruler in Council or the Yang Di-Pertua Negeri in Council, as the case may be, to acquire any hill land for the purpose of preventing loss of life due to slope failure. Hill land can be acquired under this act if the land is deemed to be required for a public purpose (soil erosion control, water catchments protection and forest reserves are all legitimate public purposes). However this act should also be considered as part of preemptive measures to acquire lands which are found to be unstable, after hazard mapping is being carried out. Purchase back or compensation schemes to the landowner can be introduced to pay for the lost of land for potential development. If relocation of civilian settlement is required, the state government should undertake the task to compensate the residents at market value.

iv) The Earthwork By-Laws 1975

This is another law that relates to hill land development. According to sources in the Municipal Council Legal Committee, there are too many irregularities in the earthwork By-Laws which is not effective in ensuring that developers abide by the law. Hence some measures are required to enhance this Earthworks By-Law regulation for effective enforcement.

v) The EIA Order 1987

This order stipulates that it is mandatory to submit an EIA report for projects covering 50 ha or more. Many developers go round this law by submitting proposals for projects just under 50 ha. However, it is entirely up to the Department of Environment (DOE) to impose the EIA ruling even for projects less than 50 ha with regulations is imposed on environmentally sensitive areas such as hill lands.

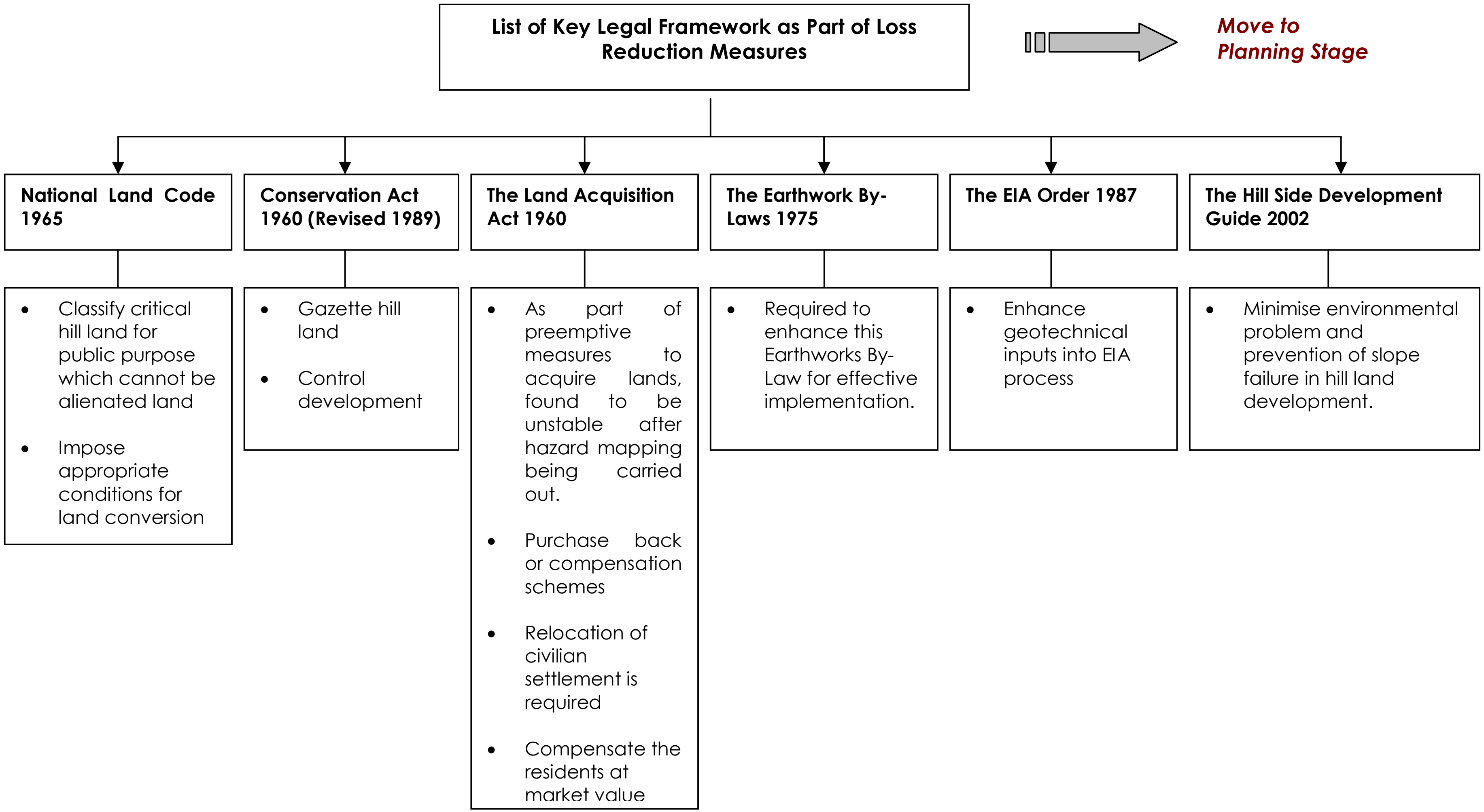
vi) The Hill Side Development Guide 2002

During the 85th Minister's meeting which was held on 21 Macrch 2002 the Ministry of Science, Technology and Environment agreed all state government explain procedures to minimise environmental problems and prevent of slope failures in hill land development.

Information on hazardous slope obtained from hazard mapping is required to be forwarded to the town and country planner. The planner could advice the local authority on appropriate measures to be considered before any development plan is approved.

Figure 8.5 A list of loss reduction measures available within the current legal framework

Figure 8.5: List of loss reduction measures available within the current legal framework.



8.3.3.2 Loss Reduction Measure during Development Planning Stages

In the planning stage, if a development involves heavy earthwork such as works exceeding 50,000m^3 of cutting and filling works, measures or steps to reduce losses from slope failures need to be incorporated. Such loss reduction measure should also consider losses due to;

i. Possible loss of life during the construction and post-construction period
ii. Direct structural damage to building and neighboring development
iii. Damage to essential facilities such as
    - Electricity and communication transmission line
    - Transportation and utility system
iv. Property losses
    - Damage of vehicle
    - Loss of agricultural and crop
v. Direct and indirect economical losses
    - Building repair and replacement cost
    - Relocation and restoration expenses
    - Wage losses
    - Building inventory losses

Considering the factors above, a detailed evaluation needs to be considered in terms of the development plan, land use, engineered slope stabilisation works and adequacy of factor of safety derived. The current development guidelines need to incorporate loss reduction measures by dictating the following:

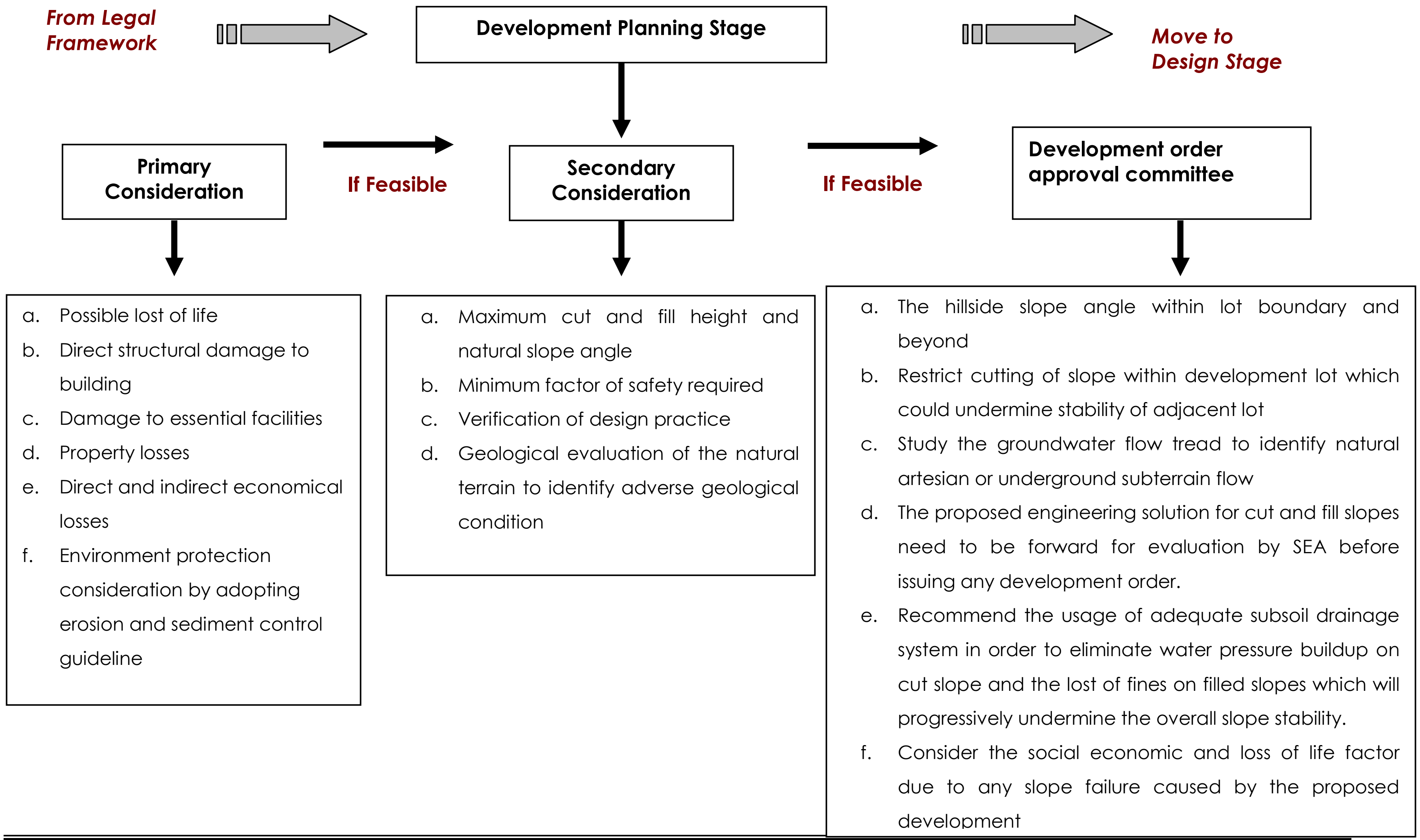
i. Maximum cut and fill height and natural slope angle allowed in the proposed development lot
ii. Minimum factor of safety required for stability by considering the potential losses that could be incurred.
iii. Verification of design practice adopted
iv. Need for geological evaluation of the natural terrain to identify adverse geological condition and natural ground water flow

The current guideline from hill land development (Hill Side Development Guide 2002) is based on slope angle classification which should also consider slopes beyond lot boundary before approving the development order. For example, in some cases the hill slope toe angle is less than 25 degree within the development lot boundary. However rapid increment in slope angle is observed beyond the proposed development lot boundary. Hence before a development order is issued, an overall terrain mapping need to be furnished by the developer together with the slope angle and hazard classification for the approving authority, evaluation. The evaluation exercise should consider the following:

i. The hill land slope angle within lot boundary and beyond
ii. Restrict cutting of slope within development lot which will progressively undermine the stability of slope at adjacent lot
iii. Study the groundwater flow tread to identify natural artesian or underground subterrain flow
iv. The proposed engineering solutions for cut and fill slopes are required to be forwarded for evaluation to the authorities or SEA before any development order can be issued
v. Recommend the usage of adequate subsoil drainage system in order to eliminate water pressure buildup on cut slope and the lost of fines on filled slopes which will progressive undermine the overall slope stability.
vi. Consider the social economic and loss of life factor due to any slope failure caused by the proposed development.
vii. Include environment protection consideration by adopting erosion and sediment control guideline.

The creation of durable and effective solutions for a development planning approval guideline for slopes under the National Slope Master Plan (NSMP) will require a continuing dialogue among practicing engineers and authorities involved directly or indirectly in order to fine tune the steps required to be taken to reduce losses due to slope failure. An effective NSMP will require a combination of engineering and management solution to ensure coordination, and consortium-type decision making to accommodate the multi-jurisdictional, cooperative nature of approval committee. The established working committee should be represented by federal and state governments, academia, and private practitioner to review critical development plan. The proposed framework for loss reduction measures during the development planning stage is shown in **Figure 8.6.**

Figure 8.6: Framework for loss reduction measures during development planning stage



8.3.3.3 Loss Reduction Measure during Design Stages

To effectively reduce losses during the design stage, various steps need to be taken into consideration in Malaysia especially on:

i) Research on Slope Engineering

Perform hazard and risk management or mapping to evaluate how the impacts of a single or multiple hazards can be reduced. This involves undertaking detail study of the project site. The fundamental view to incorporate risk and loss analysis is to consider all risk factors faced by a populated area in terms of slope failures and to develop a risk management strategy accordingly. These sources of problems can range from common occurrences of minor slope failure to major disasters. Hence, the establishment of a systematic research approach in order to develop standards or guidelines for Malaysian engineering society to is crucial.

ii) Toward Total Risk and Loss Management Framework

The bottom line of slope hazards and risk management is often expressed in terms of reduction of death and injuries, and/or reduction of the monetary losses associated with slope failures. The principle is not to minimise risk, but rather to maximize the public net benefit. Thus, cost-benefit analysis should be an integral part of risk analysis. Risk, cost and reliability are fundamental to engineering analysis. Engineers are required to combine scientific knowledge and associated theory with professional experience to estimate the workability of a design. Engineering planning, design, construction, and operating policies are based on formal codification of this scientific knowledge and experience into accepted practice. Engineers relied on safety factors to account for the uncertainty in estimating how the system would perform. Reliability engineering deals with failures of any type, whereas the recent interest in risk and cost analysis has been prompted by failures that cause problems.

iii) Improvement in Standards and Code of Practice

Improvements in code of practice and standards are needed in the engineering aspects of landslides. Some of the steps that can be taken are;

a. Provide funding to attract academic researchers and other professionals to conduct research on landslide prevention measures
b. Examine social economic issues relative to landslide prevention acceptance and enforcement
c. Redefine land use standards to give more attention to factors causing landslide to create safer living standards
d. Implement a nationally recognized and voluntary standard
e. Improve development performance provisions including national and state uniformity combined with improved and easier methods for slope property definition and design
f. Improve analysis and design procedures for slope design works to ensure quality to the national performance requirements
g. Develop more effective ways to integrate the scientific input from physical sciences, social sciences, and engineering aspects, together with the views from other stakeholders, in the process of setting land use and landslide prevention standards
h. Implement stringent site investigation works together with quality and reliable laboratory works in order to obtain reliable test results

iv) Integrating Loss Reduction Measures as Part of Slope Analysis

In order to minimise losses associated with slope failures, it is best to integrate loss reduction measures as part of slope analysis. Hence it is recommended to research and develop some of the following hazards mitigation measures;

a. Develop effective and economical methods that can be implemented in the field to evaluate and retrofit existing hazardous settlement or infrastructure subject to natural and man-made landslide
b. Develop technologies to diagnose and assess the condition and components for slope under pre and post-failure situation

c. Develop outage engineering management technologies to reduce loss of live, facility downtime and develop rapid rehabilitation and construction methods
d. Built up the knowledge needed to set system performance standards, evaluation procedures, codes, and criteria for natural and man made landslide hazard conditions in proximity to major lifeline systems including public and private utilities
e. Develop high-tech systems to facilitate infrastructure maintenance and operations such as emergency, damage control, recovery and service restoration following a landslide.

During the design stage, engineers are required to identify the possible factors causing landslides and their impact on society and economy in order to minimise losses. In term of risk to life and economic losses as a consequence of slope failure, the major factor to be considered in any slope study and mitigation measures is the proximity of the slope or earth retaining structure to populated areas, traffic and building as shown in **Figure 8.7.** Considering the risk factors involved in slope design, a guideline for hill land development was circulated by Ministry of Science, Technology and Environment on 21st March 2002. The slope classification proposed under the circulation is tabulated in **Table 8.1.**

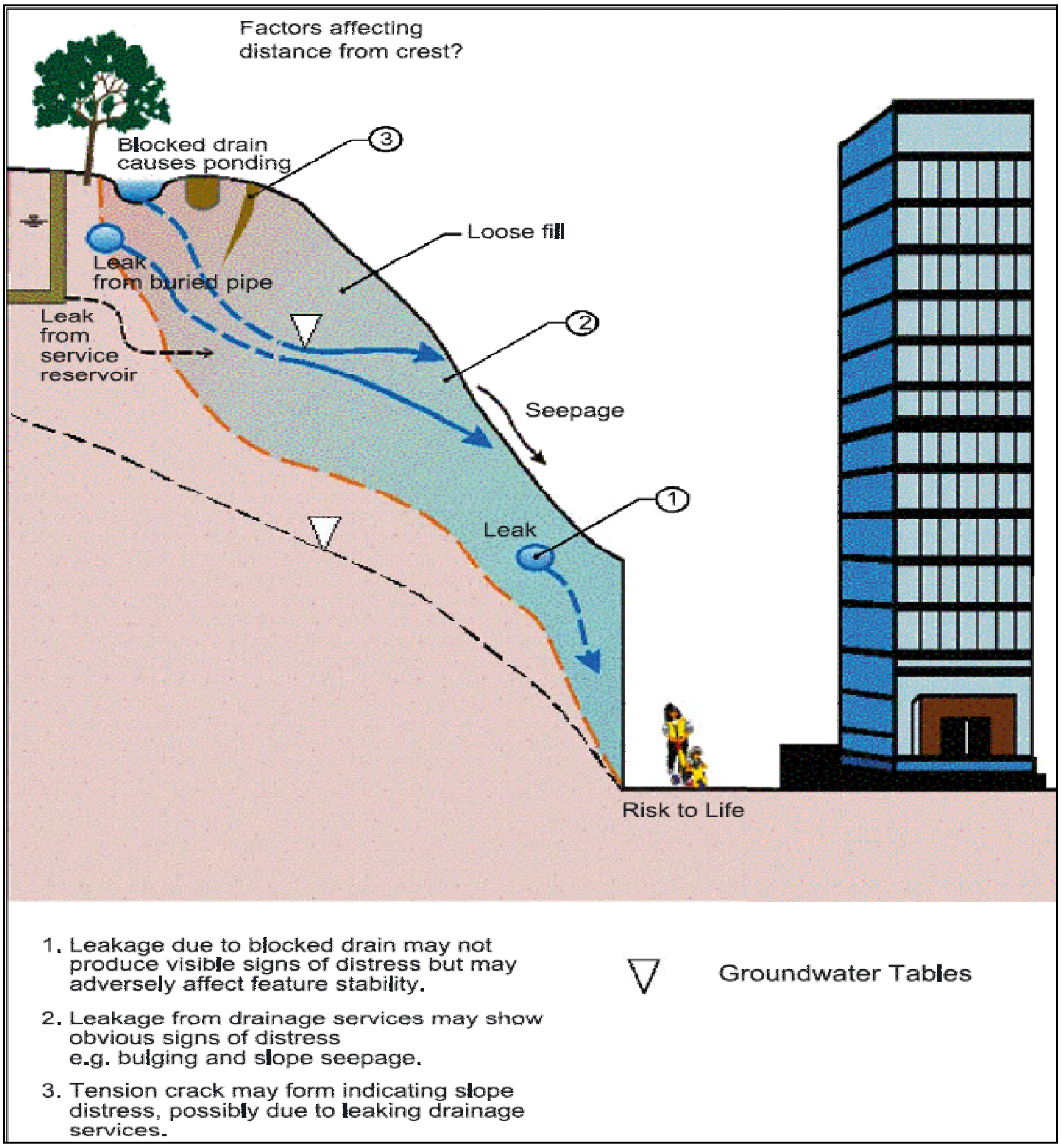


Figure 8.7: Contribution of poor maintenance for slope instability (A.K.L. et al. 2004)

Table 8.1: Guidelines for physical development

Class I and Class II	• Development is allowed for hill land with slope angle less than 25 degree • Complied to Garis Panduan Pembangunan Di Kawasan Bukit 1997 Jawatankuasa Kerja Tanah (JKT) and Garis Panduan Kawalan Hakisan dan Kelodakan ,1996, Jabatan Alam Sekitar (JAS)
Class III	• Development is allowed for hill land with slope angle ranging between 26degree -35 degree • However, an environmental impact assessment (EIA) report must be prepared. **Scope of EIA** • Follow the requirements under the Handbook of EIA Guidelines 2001 • Geology and geotechnical report must to be prepared • Submit erosion risk map • Propose procedures to maintain slope stability and erosion control measures. • A detailed EIA procedure and report is required for development area which has slope angle of 26 - 35 degree an covers 50percent or more of development area.
Class IV	• Development is not allowed on hill land with slope angle exceeding 35 degree
General Items	• For development sites development is restricted only to areas of class I, II and III

A range of triggering and contributory factors leading to a landslides are classified as shown in **Table 8.2**.

Table 8.2: Summary of landslide triggering and contributory factors (A.K.L. et al. 2004)

Landslide Triggering Factors
Rainfall intensity and rise in groundwater level • Adverse construction/human activities • Deterioration and erosion of surface • Bursting and leakage of buried water services • River erosion and flooding contributory factors • Adverse geological conditions • Substandard site investigation works • Inadequate design practice • Poor construction works • Adverse topographical conditions • Inadequate maintenance works

vii) Incorporation of Rainfall Intensity as Primary Input for Early Warning System in Design Stage

Rainfall intensity is one of the main factors contributing to landslides in Malaysia. With average annual rainfall of about 2000mm - 2500mm, rainfall-induced slope failures are common in Malaysia. Hence, an early warning system based on rainfall intensity and duration can be introduced in the design stage as a loss reduction measure. Based on the works of Brand et al (1984) and Kay (1988), most of the slope failures in Hong Kong occurred within four hours after peak hourly rainfall and less than 10percent of landslides occurred 16 hours after the peak hourly rainfall. As a preliminary guide, landslide warning could be issued if a 24-hour rainfall is expected to exceed 175mm or a 60 minute rainfall is expected to exceed 70mm, for which the probability of a severe landslide occurring is about 15 percent (kwong et al 2004). **Table 8.3** shows a guide on rainfall intensity and apparent condition of slope. Using JPS (Jabatan Pengairan dan Saliran) hydrology network data, design analysis and monitoring works can be conducted.

Table 8.3: Shows Rainfall Intensity and Apparent Conditions of Slope (A.K.L. et al. 2004)

Rainfall Intensity Centre	Apparent Condition of Slope
≥ 25 mm/day	Show signs of surface erosion
≥ 50 mm/day	Surface erosion intensifies
≥ 100 mm/day	Stability deteriorates, marginally stable slope may deform and move
≥ 150 mm/day	Marginally stable slope may deform or collapse
≥ 200 mm/day	Marginally stable slope may deform or collapse Stable slope may also show signs of instability
≥ 250 mm/day	Stable and well-vegetated slope may also deform or collapse

By incorporating the loss reduction measures discussed above, a framework is proposed for loss reduction measures during the design stage as shown in **Figure 8.8.**

Figure 8.8: Framework for loss reduction measure during design stage

From Planning Stage

Design

Move to Construction Stage

Primary Loss Reduction Measures

- Integrate research work into engineering practices for slope stabilisation works
- Move forward towards total risk and loss management framework
- Perform continues improvement on standards and codes based on research finding and experience gained
- Integrating loss reduction measures as part of slope stability analysis.
- Implement stringent site investigation works together with quality and reliable laboratory works.

Addressing Landslide Triggering and Contributory Factor

- Rainfall intensity and, rise in groundwater level, etc.
- Adverse construction and human activities
- Deterioration and erosion of surface
- Inadequate maintenance works
- Adverse geological conditions
- Inadequate design practice
- Poor construction works
- Adverse topography condition
- Bursting and leakage of buried water services
- River erosion and flooding contributory factors

Rainfall Intensity as Primary Part of Early Warning System in Design Stage

- Primary warning system based on rainfall intensity to be incorporate during design stage by identifying areas with heavy rainfall, population density and number of hazardous slope.
- Conduct design analysis and perform monitoring works using JPS (Jabatan Pengairan dan Saliran) hydrology network data.

8.3.3.4 Loss Reduction Measure during Construction

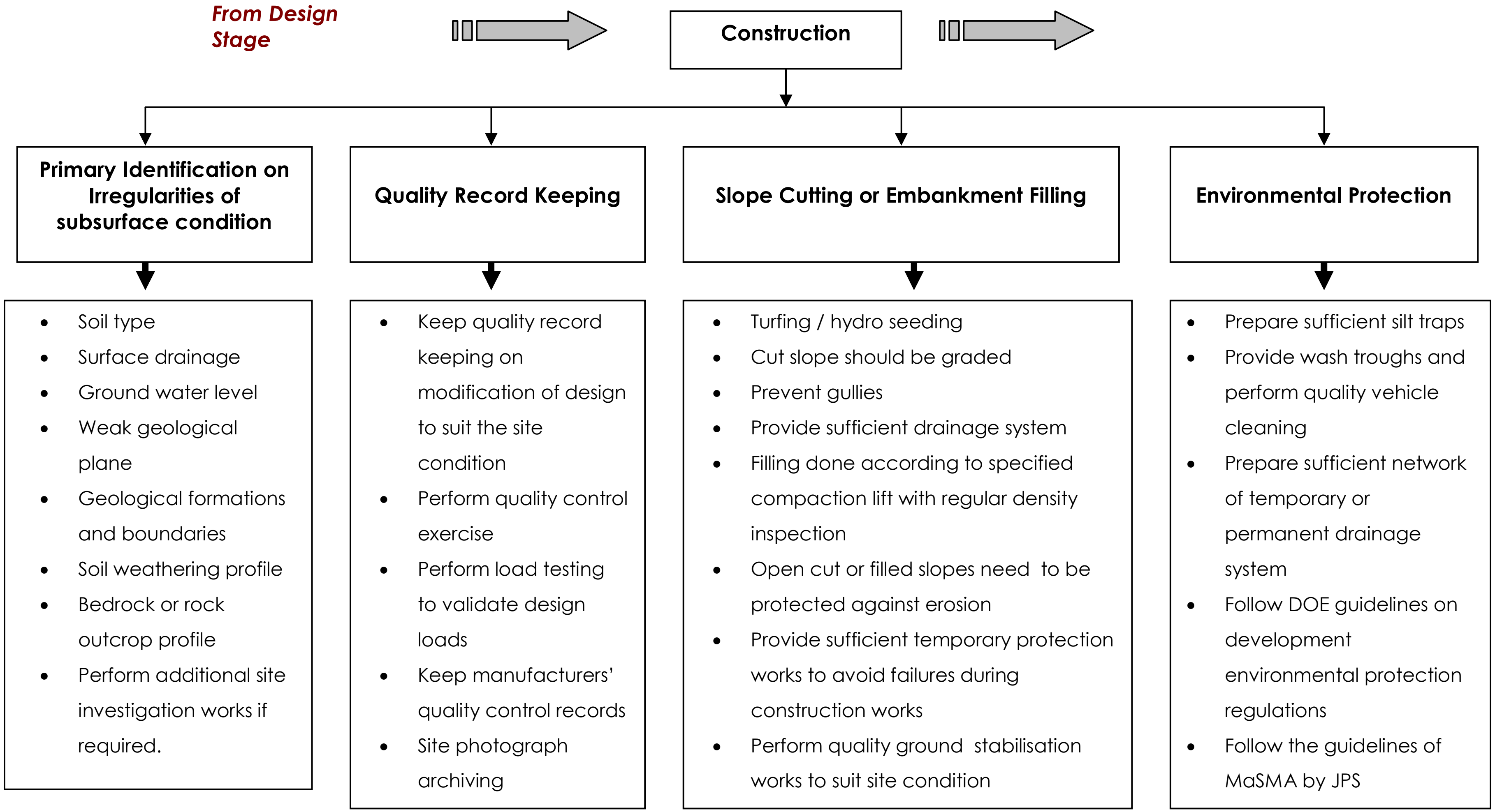
Quality construction management is an important factor for hillside development. Guidelines should be followed during supervision of such as development especially on the formation of cut and fill slopes. The supervising individual should have sufficient knowledge and experience in geotechnical engineering to identify irregularities of the subsurface condition such as soil type, surface drainage, ground water level, weak plane such as soft clay, geological formation and boundaries, soil weathering profile and bedrock or rock outcrop profile that might be different from that envisaged and adopted in the design. If required perform additional site investigation work is needed to verify the subsoil profile, especially at areas of soft clay and lime stone bedrock.

Project managers and site staff are required to keep detailed records of the work progress and the site conditions when carrying out the works, in particular when irregularities such as clay seams and significant seepage of groundwater are observed. Quality record keeping must be carried out on modifications to the initial design to ensure that they suit site conditions. Quality control exercise should include, record keeping of manufacturer's quality control records, field laboratory load testing records to validate design loads and other tests carried out. Sufficient photographs of the site before, during and after construction should be taken and archived. These photographs should be supplemented by information such as date, weather conditions and irregularities of the subsoil conditions observed during excavation.

During slope cutting or embankment filling works, it is important to provide sufficient drainage system for both temporary and permanent works. There must also be sufficient temporary protection works to avoid failures during construction works. For of cut or filled slope stabilisation must be provided sufficient and quality stabilisation solutions. As for embankment filling, it is must to be done according to stringent compaction specifications with regular density inspection. The surface of both cut and filled slope both cut and fill are required to be protected against erosion and gully formation using surface reinforcement , turfing or hydro seeding.

As for the environmental protection works, it is important to prepare sufficient silt traps and wash troughs and to provide sufficient drainage to prevent any damage to the environment which could cause water pounding and flush flood. Developers and authorities are required to follow Department of Environment's DOE guideline on environmental protection works MaSMA regulation during construction work. **Figure 8.9** shows the framework for loss reduction measures during the construction stage.

Figure 8.9: Framework for loss reduction measures during construction stage



8.3.3.5 Loss Reduction Measures by Enhancing Maintenance, Management and Monitoring of Slope

A of monitoring and observational approach need to be adopted as part of maintenance works on critical slopes. Data collected during monitoring and observation could be used for back analysis of engineering parameters and failure mechanisms development. The cost for these works should be incorporated as part of annual budgeting by the state government to reduce the likelihood of slope failure. SEA shall to undertake the task of performing engineering audit and issuing of certificates of compliance for critically hazard slope. The agency shall also oversee and monitoring slopes as well as ensure allocation for emergency response and recovery fund. Some of the steps that need to be taken as part of loss reduction measures are;

i. Register of slope details or information (geomorphology) in order to prioritise the mitigation measures based on the data obtained from early warning systems.
ii. Provide slope information to the public, to create public awareness of the potentially hazardous slope and be responsible for the slope maintenance and repair works within and beyond the lot boundary.
iii. Establish a pool of specialized consultants contract so that wider professional resources can be gathered to mitigate the slopes in a shorter period of time.
iv. Establish an of external review board to create a channel for technical exchange of latest developments in technology and research.
v. Establish of landslide warning system for early notification of potential hazards to the public so that people can stay away from slopes during heavy rainfall.
vi. Establish team of emergency response professionals staffs who can arrive at a landslide location within the earliest possible time to provide advice for restoration or temporary stabilisation repair works and gather firsthand geological information for detailed engineering failure studies.
vii. Identify of maintenance team for slopes and enforce regular inspection, review and maintenance of slopes.
viii. Provide education to the public regarding proper registration, maintenance of slopes and reporting of landslides.

ix. Create a feedback centre for the public on deteriorating slopes for the authorities to take intermediate action.

x. Set requirements for housing renovation plans to include earthwork proposal if the structure is next to or on top of a slope.

The proposed framework for loss reduction measures by enhancing maintenance, management and monitory of slopes is shown in **Figure 8.10.**

Figure 8.10: Loss reduction measures by enhancing maintenance, management and monitoring of slope

From Construction Stage →

Loss Reduction Measures by Enhancing Maintenance, Management and Monitoring of Slopes

↓

- Register of slope details/information (geomorphology)
- Establish consultancy contracts to gather wider professional resources
- Establish landslide early warning system
- Create centralized slope management solutions
- Provide education to the public regarding proper registration, maintenance of slopes and reporting potential landslides
- Create a feedback centre from the public on deteriorating slopes for the authorities to take immediate action
- Set requirements for housing renovation plans to include earthwork proposal if the structure is next to or on top of a slope.

8.3.3.6 Long-term Loss Reduction Measures by Adopting Landslide Preventive Measures (LPM)

Along with the measures considered for loss reduction measures to address the necessary requirement to be adopted in slope engineering works to prevent or minimise the occurrence of landslide and loss of life and construction of substandard slope, LPM are also required to be outlined and implemented to upgrade existing substandard slopes.

Under the LPM programme batches or areas of new and old development are required to be selected to determine the risk ranking of the slopes. The risks posed to the community and the possible fatalities caused by slope failures will be studied in detail. Slopes that are found to be below safety standards and at high risk are required to be upgraded under the LPM programme.

The task of upgrading is required to be undertaken by the land or property owner or with input from the government. Hence, a systematic approach is required to catalogue the slopes that were found to be substandard for both government and private man-made slopes. The programme under the LPM can be conducted in two stages, namely the preliminary and detailed study phases of the area specified for LPM works.

i. Preliminary Study

Under the preliminary study, the slopes within an area are assessed for consequence of failure and subjective judgment made on the likelihood of preventive measures being necessary. Hence the main purpose of the preliminary study is to identify slopes that require detail study and also identify slopes with immediate and obvious danger. Aerial maps of the site showing the hazard, and risk ranking map can be produced during the preliminary study stage.

ii. Detailed Study

As for the detailed study programme, stability assessment of an existing slope is required to be made to decide whether upgrading works would be necessary. The decision will be made based on a review of background information of the slope, examination of the slope history and characteristic study of aerial photographs, site observations, and geotechnical stability assessment and by detail ground investigation.

The detailed study output should contain:

i. <u>Recommendation for upgrading works</u>

This would list out a series of possible upgrading works that can be implemented to undertake the LPM works.

ii. <u>Requirement for further investigation to perform upgrading works</u>

A detailed site investigation needs to be carried out in order to propose a suitable strengthening solution for the substandard slope. The site investigation should encompass subsoil and groundwater level investigation by means of boreholes, site geology assessment and geomorphology mapping of the site. The site investigation report shall contain details such as the material of the slope and soil strength parameters. Geology and geomorphology reports should have output from surface investigation and topographical survey works. Geology reports are prepared by geologist based on a site visit to examine the actual site condition and the possible slope instability due to geological formation. Geomorphology mapping is also required to be carried out to identify external and visible elements of instability on the slope, interpret the likely mode of failure and assess the stability of the slope. It is also used in identifying the suitable slope rehabilitation scheme which needs to be carried out as slope protection measures. The substandard slopes can be stabilised by one or a combination of any or all of the following method:

a. Removal of potential landslide soil material and replacing it with engineered fill
b. Shear keys with drainage system
c. Buttress wall
d. Removal of top/ lower the slope height
e. Retaining wall
f. Steel netting system with soil nails
g. Soil nails
h. Incooperating subsoil drainage system, such as horizontal and trench drains

iii. Recommend other line of actions required such as traffic management, evacuation of residents and preparation of temporary access and shelter.

a. Execution of LPM Works

As the majority of the of slopes identified for LPM works would be those constructed prior to the country's hillside development guidelines and within the old development zones, the implementation of LPM will have direct social and financial impact on the residents. Hence, during execution of LRM works, the key consideration are:

a. Engineering aspect of the solution
b. Social aspect during execution of LPM
c. The cost and financial aspect of LPM works

The process flow for LPM works is shown in **Figure 8.11.**

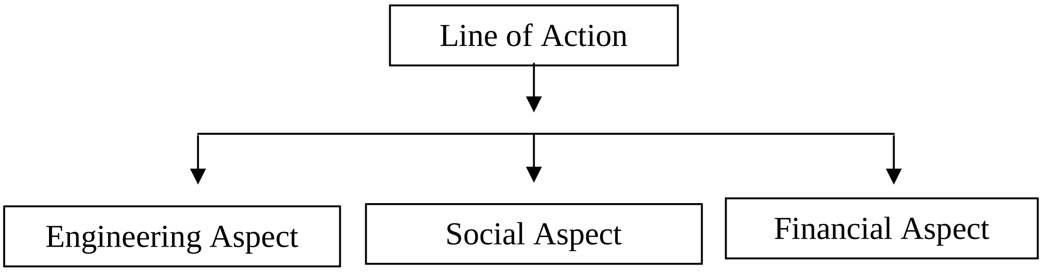


Figure 8.11: Execution of LRM works

i. Engineering Aspect

the area required for rectification works will be reevaluation in the aspect of engineering how to execute the works. Input for re-evaluation will include site visits geotechnical assessment reports and recommendations made for LPM works. Localized area will – evaluated to determine how upgrade along with the major works when minor landslide risk potential identified during rectification works. Plumbing and other services will be considered during upgrading works to ensure no leakage.

After completion of the works, regular maintenance inspections and works are necessary to keep the site in good condition. As for the general vicinity, of the rectified site maintenance inspections and works are recommended to be carried out to reduce the probability of instability of slopes and retaining walls that are not up to the current geotechnical standards for design and construction.

Maintenance inspections are divided into four categories:

a. Routine maintenance inspections, which can be carried out by any responsible person with no professional geotechnical knowledge

b. Engineer inspections for maintenance, which should be carried out by a professionally-qualified geotechnical engineer
Regular check of buried water-carrying services, which should be carried out by a specialist leakage detection contractor

c. Regular monitoring of special measures, which should be carried out by professionals with special expertise in the type of monitoring service required. Such monitoring is only necessary where the Long-term stability of the slope or retaining wall relies on specific measures that are liable to become less effective with the passage of time, e.g., ground anchored slope or wall.

The following is checklist for routine maintenance inspection works:

a. Clearance of accumulated debris from drainage channels and slope surface,
a. Repair of cracked or damaged drainage channels or pavement,
b. Repair or replacement of cracked or damaged slope surface cover
c. Unblocking of weepholes and outlet drainpipes
d. Removal of any vegetation causing severe cracking of slope surface cover and drainage channels
e. Re-grassing of bare soil slope surface areas
f. Repair of missing or deteriorated points in masonry walls
g. Removal of loose rock debris and undesirable vegetation from rock slopes or around boulders
h. Repair of leaking exposed water-carrying services
i. Repair or replace rusted steel slope furniture
j. Maintenance of landscape treatment on the slope

ii. Social Aspect

To reduce the landslide risk posed by private slopes, private owners must take up their responsibility to maintain private man-made slopes and to upgrade those that are substandard. This responsibility is stipulated by law. An example of actions required of private owners is to inspect and repair private underground drains and water pipes which may affect the stability of adjacent slopes.

a. Promote public awareness for safe slopes

Many private owners are unaware of their slope maintenance responsibility or, as laymen, they do not possess the required knowledge or expertise in slope improvement or maintenance works. It is necessary to provide the public with slope information, identify the ownership of each man-made slope in terms of maintenance responsibility, and provide an advisory service on how to maintain slopes. Public education will be set up on slope maintenance and enhance our public communication channels on slope safety matters. To minimise the adverse consequences of landslides to the community, SEA will educate the public on slope safety so that they can take personal safety precautions to protect themselves and their families in times of heavy rainstorms.

iii. Financial Aspect

Loans should be offered to private landowners and local authorities for the investigation and upgrading of substandard slopes. Loans will to cover the cost of investigation and upgrading work of the substandard slopes involving the following activities :

a. Employment of authorized persons and registered professional engineers (geotechnical) to study, design and supervise the slope upgrading works;
b. Employment of registered contractors to carry out ground investigation works including laboratory testing; and
c. Employment of registered contractors to carry out slope upgrading works.

8.3.4 Develop Educational Programmes for Federal, State and Local Authorities on Risks and Costs of Landslide Hazards

There is a need for education programmes for stakeholders the legal framework, development approval procedures, design checklist, monitoring of construction practice and regular maintenance. The agenda of educational programmes under loss reduction measures are driven by the objective of providing the stakeholders with wider knowledge an hands-on experience managing slope-related matters, especially landslide prevention methods, and mitigation technologies. Hence it is important to undergo regular training locally and abroad to develop quality decision makers.

At present, there is no dedicated institute or organisation with structured teaching or training modules that are focus specifically on slopes and landslides. However, the need for professional geotechnical engineers is urgent. Even within SEA itself, there is a need for well-trained engineers and experienced professional engineers. Hence, intensive educational and hands-on training programmes must be implemented immediately. As the training programmes require time to produce experts or trained personnel, it is essential to prioritise the groups of stakeholders for immediate training and the training modules required.

i) The Objective of Education Programmes as Part of Loss Reduction Measures

The objective is to develop an educational framework for decision makers and practitioners such as federal, state and local authorities, engineers, architects, scientists, geologists, mineralogists and undergraduates in assessment of landslide hazards and risk mapping, mitigation measures, slope stability analysis and design, construction practice, and factor of safety analysis. Some of the strategies to achieve the objectives are to:

a. Develop training programmes for decision makers in landslide hazards map, assessment, and other technical information for planning, preparedness and mitigation.

b. Develop a training curriculum for engineering undergraduates on planning, design, construction and maintenance of slopes

c. Continuing Professional Development (CDP) training programmes for decision makers, professionals, practicing engineers and undergraduates

d. Develop administrative training programmes for federal, state and local government staffs in implementation of guidelines for slope management, responding to landslide disasters and providing scientific and technical information for response and recovery efforts.

ii) Current Educational Awareness

At present, training or educational programmes on slope engineering are not centralised or interlinked among decision makers (the authorities) and professional practitioners.

Hence it is important to have a well-structured training programme or coordinated approach to ensure that required education are provided to professionals decision makers and government officers who are directly and in directly responsible for slope management, landslide hazard mitigation, emergency response and recovery. Junior engineers and undergraduates also require training to carry out proper engineering analysis and design of slopes. To ensure that the programmes are standardised SEA could take the lead in providing the manual, modules and personnel to conduct the training. **Figure 8.12** shows the proposed education and training programme as part of loss reduction measures.

iii) Educational Programme for Decision Makers

The target audience under this programme are the federal, state and local authorities. Educational programme for decision makers should be part of the administrative training programme to enhance the engineering knowledge of district engineers, planners and technical staffs. Some of the requirements are:

a. Create indepth understanding of legal framework and implementation
b. Create awareness on the requirements of proper slope management
c. Promote understanding and implementation of hazard and risk mapping within the administration boundary
d. Provide education on how to collect topographical data from reliable sources to determine the presence of bedding facture planes, erodibility of native rock, understanding of geomorphology and field mapping, basic and advanced geological knowledge such as type of soil and rock, weathering process and erodibility of the material.
e. Create a clear picture on technical information on planning, preparedness, mitigation measures, response and recovery efforts in the event of landslides.
f. Teach how to assess potential risk and possible failure of landslides, by understanding the past history of the site, hydrological factors such as ground water table, seasonal fluctuations of groundwater table and perched water tables toward the stability of slopes.

iv) Educational Programme for Professionals

It is important to educate professional such as engineers, architects, planners, researchers and geologist to perform quality ground works before a development plan is submitted to the local authorities. Providing such education would ease the checking works of the local authorities, when the submitting consultants have interpreted the development terrain accurately with sufficient consideration for landslide prevention. Education be integrated as part of the professional development training programme for all the consultants involved in designing slope or slope engineering works. The programmes are required to cover the following:

a. Advanced technical education on slope engineering including
   - Legal framework
   - Development planning
   - Design consideration
   - Quality and safe construction practice
   - Details of slope maintenance

b. Interpret action of aerial information such as photograph and contours to identify critical areas for potential landslide

c. Educational programme on how to conduct site geomorphology and geological mapping.

d. Education on site hydrology and groundwater flow trend

The educational programmes for professionals can be conducted by the Board of Engineers Malaysia (BEM), the Institution of Engineers Malaysia (IEM) or by SEA

vi) Educational Programmes for Junior and Undergraduate Students

Creating a pool of engineers with a clear understanding of slope stability and slope engineering works in order by raising awareness of landslides and preventive measures is an another important step forward. Hence it is recommended to expose engineers at the early stage of their studies or career to landslide mitigations. By attending the educational programmes junior engineers can be rewarded through higher continuous development programme points (CDP Points). Similarly educational programmes can be adopted for both junior engineers and undergraduate students. The educational programmes for undergraduate students can be structured as part of practical training curriculum. The proposed education programmes are:

a. Provide technical information on:
   - Legal framework involved in the project development works
   - Development planning procedures
   - Design consideration to prevent landslide events
   - Quality and safe construction works
   - Understanding the needs for proper maintenance of slope

b. Introduction to landslide mitigation technologies

c. Identify the courses of landslides and avoid errors to be made during design or construction stages

d. Recognise and respond to signs of potential landslides

vi) Training curriculum for undergraduates

The training curriculum for undergraduates should cover aspects on planning, analyses, design, construction, monitoring and maintenance of slopes in line with latest local and international practices. The training can be done through structured slope engineering course work together with field trips. Hence it is proposed for local universities to look into the possibility to introduce slope engineering and landslide mitigation technologies as part of the core subject for civil engineering students.

Some of the topics that can be covered under slope engineering are:

a. Introduction to slope and landslides
b. Planning the slope or stability solutions required based on the complexity of a particular design
c. Planning of subsurface investigation and interpretation of field and laboratory test results
d. Modeling slopes and selecting the analysis cases for design
e. Understanding of the codes of practice and guidelines for stabilising slopes to obtain the appropriate safety margin
f. Practicing engineering ethics and performing quality construction works, supervision and inspection of the installation works
g. Planning and executing suitable maintenance works and failure prevention measures for slopes

vii) Field trips or practical training

a. Schedule visits to landslide areas to expose the students to the importance of slope analyses and design as well as slope strengthening works and lessons learned from past failures.
b. If possible, send the students for a short industrial training programme.
c. Invite experienced practitioners to give presentations on their experience in slope engineering
d. Collaborate with local authorities and government departments to structure the teaching module required

viii) Educational programmes for emergency personnel

Landslides occur in a sudden manner and are generally complex in nature, involving the loss of lives, damage to properties and the environment. Such event need to be addressed systematically. As such, complicated joint operations such as the coordination of resources and equipment from various agencies and rescue operation need be reviewed periodically. Specific training and educational programmes are required for all the emergency response team to undertake the task of handling landslides events, especially in the usage of special equipment to recover buried victims. Targeted government agencies for the training and education are:

a. National Security Council, Prime Minister's Department
b. Fire and rescue services department (JBPM)
c. Royal Malaysian Police (PDRM)
d. Malaysian Armed Forces
e. Special Malaysian Disaster Assistance and Rescue Team (SMART)
f. Department of Irrigation and Drainage (JPS)
g. Department of Social Welfare (JKM)

ix) Educational Programme for the Public

The public can play a part in landslide mitigation. Hence it is important to provide sufficient educational programmes on landslides, mitigation measures and maintenance works. Educational information for the public can be channeled through:

a. TV and radio talk shows or advertisements
b. Newspaper and magazine articles
c. Advertisement on billboards, TV and radio
d. Conduct public forums
e. Organise public education programmes, where the public are encouraged to attend
f. Conduct roadshows at large events
g. Visits to schools and universities to create awareness for the younger generations

Decision makers (Federal, state and local authorities and town planning officers)

As part of **Administrative Training Programme**

Understanding of development legal framework and implementation

Guideline on slope management.

Technical information for response and recovery efforts, planning, preparedness and mitigation measures

Hazard mapping

Assessment of potential risk and possible failure

Implementation of Landslide Prevention Measures

Professionals (Engineers, planners, researchers and geologists)

As Part of **Professional Development Training Programme**

Technical information on safety measures of slope design as part of

- Legal framework
- Planning
- Design
- Construction
- Maintenance of slope

Interpreting aerial information such as photograph and contours plans to identify critical areas of potential landslide and debris flow

Training on site geomorphology and geology mapping

Training on site hydrology and groundwater flow trend

Junior engineers

Training Programme as Part of **Continuous Development Programme** (CDP)

Undergraduate Students

As Part of **Training Curriculum**

Create clear understanding on landslides and the consequences

Provide Technical information on

- Legal Framework
- Planning
- Design
- Construction
- Maintenance of slope

Introduce to landslide mitigation technology

Identify basic causes of landslides

Recognise and respond to signs of potential landslides.

Emergency personnel (Emergency team, doctors, fire fighter

Training Programme

- Provide response and recovery training specific for landside disasters on

Public

- **Create public awareness on proper slope maintenance** work as part of landslide prevention measures.

Figure 8.12 Shows the proposed education and training programme as Part of loss reduction measures

8.3.5 Propose Framework of Incentive and Disincentive Schemes

In order to develop a programme that would deliver reliable and safe slope design by engineers as part of loss reduction measure, an integrated national slope design, construction and maintenance system is required. The system is proposed to begin with ***Application for Slope Stabilisation Work*** to SEA where the records of application and comment are stored in a database which are then review by the SEA to identify the performance of the submitting engineer under **Slope Design and Construction Database Review.** During review if the performances of submitting engineers are found to be poor, the engineer is requested to attend slope or geotechnical design training programme as part of a disincentive scheme. However the good performing engineers are recommended to be specialists and registered consultants with SEA as part of an incentive scheme. Details of the proposed incentive and disincentive schemes are discussed in detail in the following sections.

8.3.5.1 Application for Slope Stabilisation Works

Engineered slope or earth retaining structures proposed for development projects which require SEA review shall go through a process of application for slope stabilisation works. At SEA the applications undergo a series of design reviews with detailed consideration of design approach, type of slope (cut, fill, retained or stabilized), risk, hazard factors, safety of existing structures or services and assess if adequate considerations were given in the design as part of exercise for loss reduction measures due to slope failure.

The flow of application process is shown in **Figure 8.13** where the application will undergo a Preliminary Design Review by SEA. If the design is found to be adequate, the application proceeds ***Further design comments and recommendation by SEA*** where at this stage, recommendation to improve the safety and maintenance of slope are given with conditional approval. The information on the application and comments at this stage will be recorded into the central database. If the design is found to be inadequate, by SEA, at the preliminary design review stage the submitting engineer is required to resubmit based on *Detail design comments by SEA.* At this point all information on the application and comments will be recorded into the central database.

The next step is conditional approval with **Site Visits to Verify the Constructed Works** and the quality, safety and site record keeping. During the site visit, SEA will check how the construction work is done, looking specifically following items;

a. Construction is not done as submitted or approved specification by SEA
b. Poor quality of works
c. Non approved design or construction methods used
d. Poor house keeping and inadequate worker's safety measures
e. Inadequate or incomplete site records on material quality, load tests and installation works

Additional comments, recommendations and safety measures are suggested to be incorporated as part of the requirement for approval by SEA. Information on the site visit and the communication and recommendations made by the relevant consultants and contractors are recorded in the database. The next stage of the application process is ***Additional comment and recommendation by SEA (if required)*** especially on proposed slope maintenance works. Upon Compliance to the stipulated recommendation and guidelines the application is then proposed to the stage of **Issue certificate of compliance.**

The stored records or information on comments, recommendations and communication with the submitting engineer will be reviewed at this stage by SEA. After the full review on the records with satisfaction, SEA will issue a certificate of compliance.

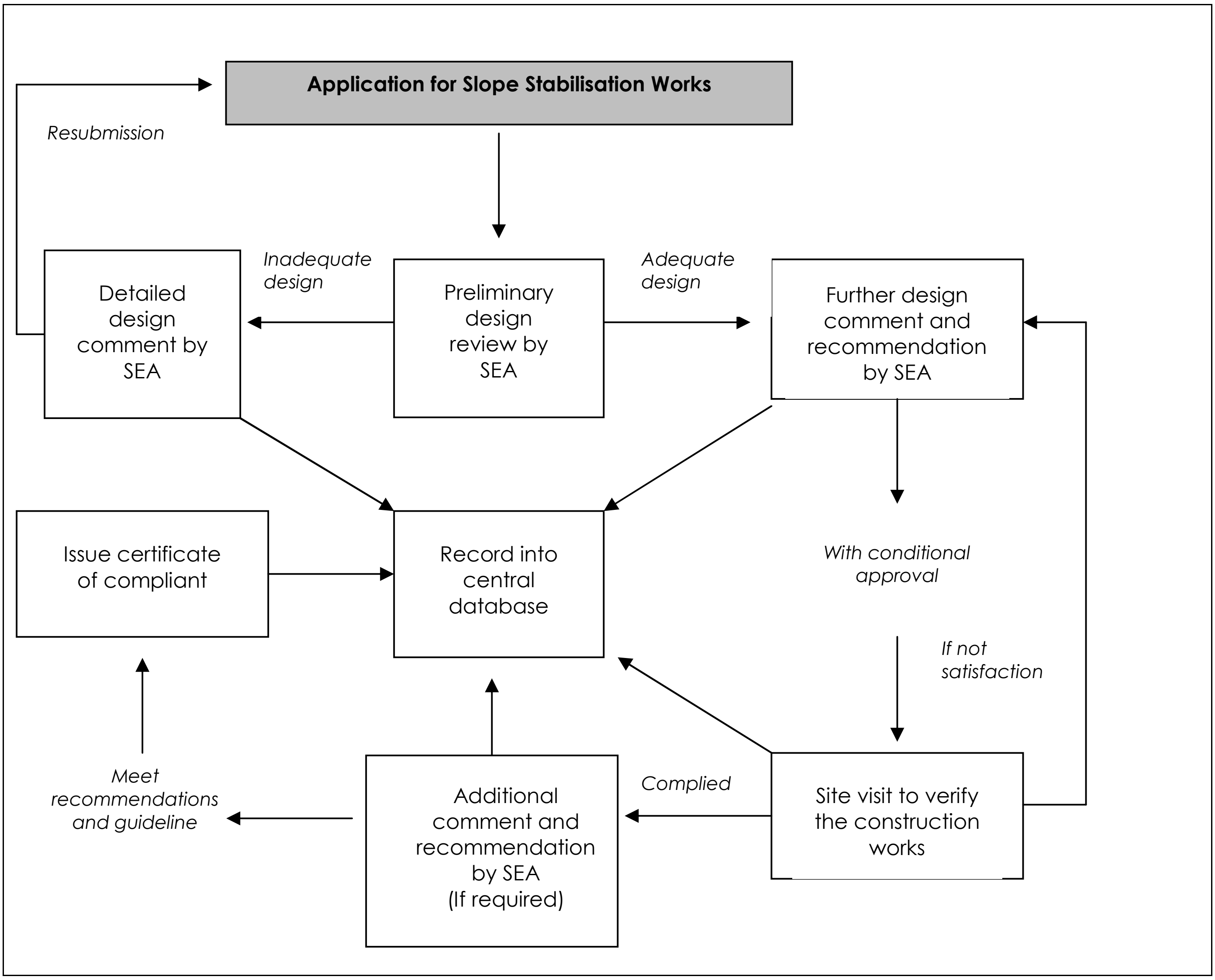


Figure 8.13: Process flow for application for slope stabilisation works.

i) Design Review by SEA

At this stage the application for slope stabilisation works shall be reviewed by SEA. The application should contain a clear explanation on slope stabilisation work which could contain a system of permanent design measures using geotechnical solution or in combination with erosion and environment protection measures. It is imperative that all phases of design be carried out in accordance with established methods and procedures to ensure that the design performance is consistent with proven past practices.

ii) Adequate Design

For SEA to validate the design and classify it as adequate or not adequate, the following criteria are used :

a. Site Investigation and Evaluation Process

The main objectives of site investigation are:

- Assess the general suitability of the site and the surrounding environments for the proposed works
- Assess the quality method and quality of site investigation being carried out together with the laboratory tests conducted, and the relevance of the site investigation works and laboratory tests in respect to the type of design works involved
- Assess how the site investigation parameters were used and interpreted for design works
- Assess the proposed safety measures and economic design for both temporary and permanent works
- Evaluate the proposed method of construction to overcome expected difficulties due to very soft or very loose ground conditions
- Explore borrow sources for material and disposal sites review for site stability and environmental preservation methods adopted
- Evaluate the effects of the proposed development works being carried out to adjacent properties
- Evaluate the proposed construction stages against any abnormalities in the sequence of work.

b. Cut and Fill Slope Evaluation

In slope stability design, cut or filled slopes must be designed to reduce soil erosion and surface runoff. As part of loss reduction measures, deciding on slope geometry should considered in term of :

- Reducing slope steepness and increasing stability
- Reducing velocity and surface runoff by increasing the distance of overland flow which results in increased infiltration and sediment collection. It also includes creating a stable environment for the establishment of plant species.

Regular maintenance is important for the working function of slope, and regular inspection proposal should be incorporated at the design, particularly after precipitation or storm runoff events. Accumulated sediment must be collected and removed. Tension cracks appearing on slopes due to minor movement are possible, hence those areas of slope should be monitored carefully and repaired if required.

c. Loads on slope

Loads imposed on slopes, such as those resulting from structures, vehicles and stored materials. should be accounted for stability analyses.

d. Shear Strengths

Shear strengths of filled materials for new construction should be based on tests performed on laboratory compacted specimens. Shear strengths of natural material should be based on laboratory tests performed on undisturbed specimens, retrieved from boreholes. During construction, materials should be examined to ensure that they are consistent with the materials on which the design was based. Records of compaction, moisture, and density for filled materials should be compared with the compaction condition and the undrained shear strengths used in stability analyses. Particular attention should be given to determining if field compaction moisture contents of cohesive materials are significantly higher or dry unit weights are significantly lower than values on which design strengths were based. If so, undrained shear strengths may be lower than the values used for design, and end-of-construction stability should be re-valuated.

e. Geotechnical Instrument and monitoring

Geotechnical instrumentation and monitoring systems can be used for the purpose of:

- Site investigation
- Design verification
- Construction control
- Quality control
- Safety
- Legal implication
- Performance

The type of instrument used will depend mainly on the criticality of the information required. The choice of instrument shall be based on:

- Critical parameters
- Ground condition
- Complementary parameters and redundant measurements
- Instrument performance
- Cost effectiveness
- Instrument life span
- Environmental conditions
- Ease of handling
- Automated data acquisition

Some of the typical instrument are:

- Settlement survey markers
- Piezometers
- Inclinometers
- Beam sensors and tilt meters
- Borehole extensometer
- Horizontal profiling gauges
- Settlement cells
- Surface extensometers
- Strain gauges
- Load cells

- Total pressure
- Thermocouples

Type of sensor or transducer used are:

- Resistance wire strain gauge type
- Vibrating wire strain gauge type
- Linear voltage differential type
- Fiber optic type

Data and test results collected in the field and laboratory should be compiled into a report. Relevant data to be included in the report are given below:

- Date of investigation with location identification number to referenced investigated location, e.g. BH1 and the GPS location
- Existing ground level at investigated location is referenced to established datum.
- Location of investigated point (i.e., coordinates) referenced to an established state or national grid.
- Drawing showing location of investigation with sufficient topographical details.
- Date of testing, sample location and depth retrieved
- Methods of investigation and testing, equipment used, date commenced and date completed
- Investigation logs that describe material type (both engineering and geological) with depth
- Ground water levels encountered should be reported
- Field test results in summary and details
- Laboratory test results in summary and details

f. Ground Water

Stability of natural slope is often related to high internal water pressure associated with wet weather periods. It is appropriate to analyse such conditions as long-term stability and steady-state seepage conditions using drained shear strengths and the highest probable position of the piezometric surface within the slope. For submerged and partially submerged slopes, the possibility of low water events and rapid drawdown should be considered.

g. Instrument for Slope Monitoring

There is a wide array of instruments than can be used to measure and monitor the kinematics, hydrological and climatic parameters, ranging from simple mechanical devices to sophisticated electronics equipment and satellite technology.

Table 8.4: Summary of instruments and methods for slope monitoring works.

Parameter	Instruments/Methods
Surface deformation	• Surveying methods, including GPS • Crack gauges/surface extensometers • Tiltmeters • Multi-point liquid level gauges • Photogrammetry • Satellite images • Remote video
Subsurface deformation	• Inclinometers • Simple borehole deformation measurements • Fixed borehole extensometers • Slope extensometers • Shear pin indicators • In-place inclinometers • Multiple deflectometers • Acoustic emission monitoring • Time-domain reflectometry (coaxial cables) • Pendulum
Groundwater pressure	• Standpipe piezometers • Vibrating wire piezometers • Pneumatic piezometers • Multi-point piezometers
Stresses in slope reinforcement	• Load cells • Strain gauges
Drainage flow (from borehole drains, trench drains, adits), springs and surface runoff	• Bucket and stopwatch • Water level behind weir(s) • Pipe flow meters
Climatic conditions	• Rainfall gauges • Thermometers • Barometric pressure gauges • Evaporimeters • Tensiometers

h. Possible Slope Stabilisation Solutions

The following are some of aspects should be taken into account when selecting stabilisation solutions:

- Re-sloping (re-profiling) by flattening the slope or creating berms or benches can only be effective in unpopulated areas and where excavation works can be carried out without disturbance.
- Drainage and surface protections are generally the most cost-effective solution. In tropical regions, such as Malaysia, heavy rainfall is the most frequent triggering mechanism for landslides. Therefore, slopes generally will not be safe without a high quality surface and internal drainage system.
- Gravity or concrete walls tend to be economical for small slope heights up to 3m. Beyond this height, a soil reinforcement solution may be much more cost-effective.
- Soil reinforcement solutions comprise geosynthetic and other types of reinforcement for wall. It is a low cost solution, especially for wall higher than 3 m.
- Soil nailing in general presents the minimum cost in stabilising excavated soil slope. It is easily applicable to vertical inclined slopes. For case of slopes with rock and soil interface, rainfall on the rock scrap may find its way into the soil mass at the interface, weaking the interface and leading to landslides. Therefore, in this case the most effective way of avoiding landslides is to build a drainage system to collect the rainwater.

i. Factor of Safety

Appropriate factors of safety are required to ensure adequate performance of slopes throughout the design life. The most important items that will determine the magnitudes for factor of safety are uncertainties in the conditions being analysed, analysis parameters and consequences of failure or unacceptable poor performance. What is considered an acceptable factor of safety should reflect the differences between old and new slopes, for new slopes, where stability must be forecast; for existing slopes, when information regarding past slope performance is available. A history free of signs of slope movement provides firm evidence that a slope has been stable under the conditions it has experienced.

Conversely, signs of significant movement indicate marginally stable or unstable conditions. In either case, the degree of uncertainly regarding shear strength and piezometric levels can be reduced through back analysis. Therefore, values of factors of safety that is lower than those required for new slopes can often be justified for existing slopes. Historically, geotechnical engineers have relied upon judgment, precedent, experience and regulations to select suitable factors of safety for slopes. Reliability analyses can provide important insight into the effects of uncertainties on the results of stability analyses and appropriate factors of safety.

j. Some other Important Factors to Consider as Part of Loss Reduction Measures

Some of other important factors that need to be considered as part of loss reduction measures are re-vegetation of slope and erosion control methods.

- **Re-vegetation**

Re-vegetation is the establishment of annual and perennial plant material for temporary and/or Long-term soil stabilisation to stabilize soil from raindrop impact, reduce the velocity of surface runoff, prevent erosion by water, and also restore the natural aesthetics of the slope. Stable vegetation generates natural mulch and provides organic matter for soil nutrient recycling. Re-vegetation practices also assist to improve infiltration and transpiration and can trap sediment and other particulates, which eventually protects the environment.

- **Erosion Control Method**

Soil erosion is a natural slow process. However with human activities the rate of erosion and resulting environmental damage could occur at an accelerated rate,

One of the consequences is Sediment deposition causing serious consequences to the environment and resulting in flood related damages.

However, erosion can be controlled by :

- o Implementation of erosion mitigation methods or technologies
- o The usage of sediment control system such as silt trap or fence
- o Introduction of rapid rehabilitation scheme by vegetating the affected area as soon as possible

Some of soil erosion mitigation measures are:

- o Intercepted precipitation with increased infiltration to reduce runoff
- o Erosion control blanket/mulch
- o Bonded fiber matrix
- o Reinforced turf

Understanding the soil erosion mechanism is critical to designing soil erosion measurement systems and developing soil erosion control techniques.

iii) Inadequate Design

If the submitted design is found to be inadequate, resubmission will be required to be done based on review and comment by SEA. Inadequate design is defined as the Design that has :

a. Inadequate information to sufficiently evaluate the design validity by SEA
b. Inadequate design factor of safety, based on SEA evaluation.
c. The slope design is not compliant to SEA legal or development guidelines.
d. The stabilisation system adopted is not approved by or not familiar to SEA

iv) Database

All the information at this stage regardless of whether the design is adequate or inadequate, are required to be recorded into database. The database proposed contains the following information:

a. Date of submission
b. Type of development
c. Location of development
d. Project title
e. Project owner

f. Engineers involved the geotechnical, civil, and structural works
g. Development order details
h. Slope category (fill, cut, wall or reinforced)
i. Slope identification number by SEA
j. Site geological formation details
k. Photographs of site before and after construction works
l. Comments made by agency on the design
m. Site visit details
n. Approval dates

v) With Conditional Approval

For well-presented and well-designed slope as per the guidelines of SEA, conditional approval will be given. Based on the conditional approval the construction works can commence. However, further inspection will be done by SEA to ensure the quality of works done.

vi) Site Visit to Verify the Construction Works and Records.

During the site visit to verify construction work, SEA is required to have a checklist of important factors to observed

a. Groundwater and seepage condition of site
b. Lithology, stratigraphy and geologic details disclosed by borings and geologic interpretation
c. Maximum past overburden at the site as observed from geological evidence
d. Structure, including bedding, folding and faulting
e. Alteration of materials by faulting
f. Joints and joint system
g. Weathering
h. Cementation

Additional Item which should be verified during site visit are:

a. Equipments used
b. Method of construction

c. Quality of material such as grade of concrete and soil compaction density

d. Safety measures adopted during construction works

e. Site records

f. Work sequences

i) If not Satisfaction-after Site Visit

If SEA is not satisfied by to the quality of work done and the safety measures adopted during the construction stage, additional comments by SEA is proposed to be executed by the consultant and contractor.

ii) Additional Comments and Recommendations by SEA

Recommendations should be given by SEA to improve the design or make necessary changes to suit the site condition or to compensate the poor quality of construction works. If the re-submissions meet all the recommendation and guidelines as spelled out by SEA, and all design and construction records are in order, SEA could issue certificate of compliance for the works done.

iii) Meet Recommendation and Guideline

Once the engineers comply with all the guidelines and recommendations by SEA, the application will be moved forward to issuing certificate of compliance.

iv) Certificate of compliance

The purpose of this certificate of compliance is to encourage engineers to perform quality works, and get rewarded and recognition by SEA. It is not a certificate of fitness or guarantee letter on the stability of the slope. The design and construction liability will still remain with the designer and the contractor.

8.3.5.2 Slope Design and Construction Database Review

The details of slope design and construction database are required to be reviewed for the quality of submission works and performance during construction works to identify quality engineers to be appointed as SEA's specialist.

i) Review of Submission Records

All the submission details made by the engineers which were recorded in the database will be review by SEA to categories the performance of each engineer. The performance of engineers are divided to two categories: poor performance and good performance. Poor performance means the engineer had frequent resubmission works due to inadequate design which is not according to the standards and norms, based on a review of the engineer's track record. For engineers who have shown continues good performance, without major comments by SEA will be called upon by SEA to become a specialist.

ii) Recommend to be Specialist

For engineers who have shown continuous good performance regarding to the quality of design and construction works will be call upon by SEA to become a specialist. However the engineers are required to undergo training programme under SEA. The module for the training will be prepared by SEA to ensure that the training covers a wide and detailed scope of geotechnical engineering.

iii) Recommend for SEA Slope or Geotechnical Design Training Programme

For engineers who have shown poor performance are proposed to undergo a series of geotechnical design training programme. This training programme will provide participants with the necessary knowledge and skills to design, plan, select and implement geotechnical related works. The course would focus on the guidelines to plan and design a safe slope. The course would also cover the aspects of instrumentation, design and construction methodologies for various types of slope design. Participants will also be exposed to collection of SI data processing and presentation of collected data, interpretation of processed data and reporting of results, selection of parameters, design approaches, construction sequences, specifications, installation of instrumentation calibration and maintenance

Upon completion of the course, participants will able to:

a. Recognise the needs of SEA in order to comply with the standards

b. Appreciate the needs for a well -design and constructed slope as part of loss reduction measures

c. Be able to use, interpret and understand accurately field instrumentation data

iv) Recommend to Undergo SEA Specialist Training.

The engineers who have been recommended to be a specialist are required to undergo SEA specialist training. The purpose of this training is to

a. Expose the engineers to advanced geotechnical engineering work.
b. Create awareness on the role of specialist geotechnical engineer
c. Create social responsibility towards design safety and environment friendly engineering approach
d. Build and maintain strong working relationship with SEA

v) Add to List of Consultants Register with SEA.

The specialist geotechnical engineers who has undergone specialist training programme with SEA will be listed as a consultant registered with SEA.

Figure 8.14 shows the process flow for slope design and construction database review.

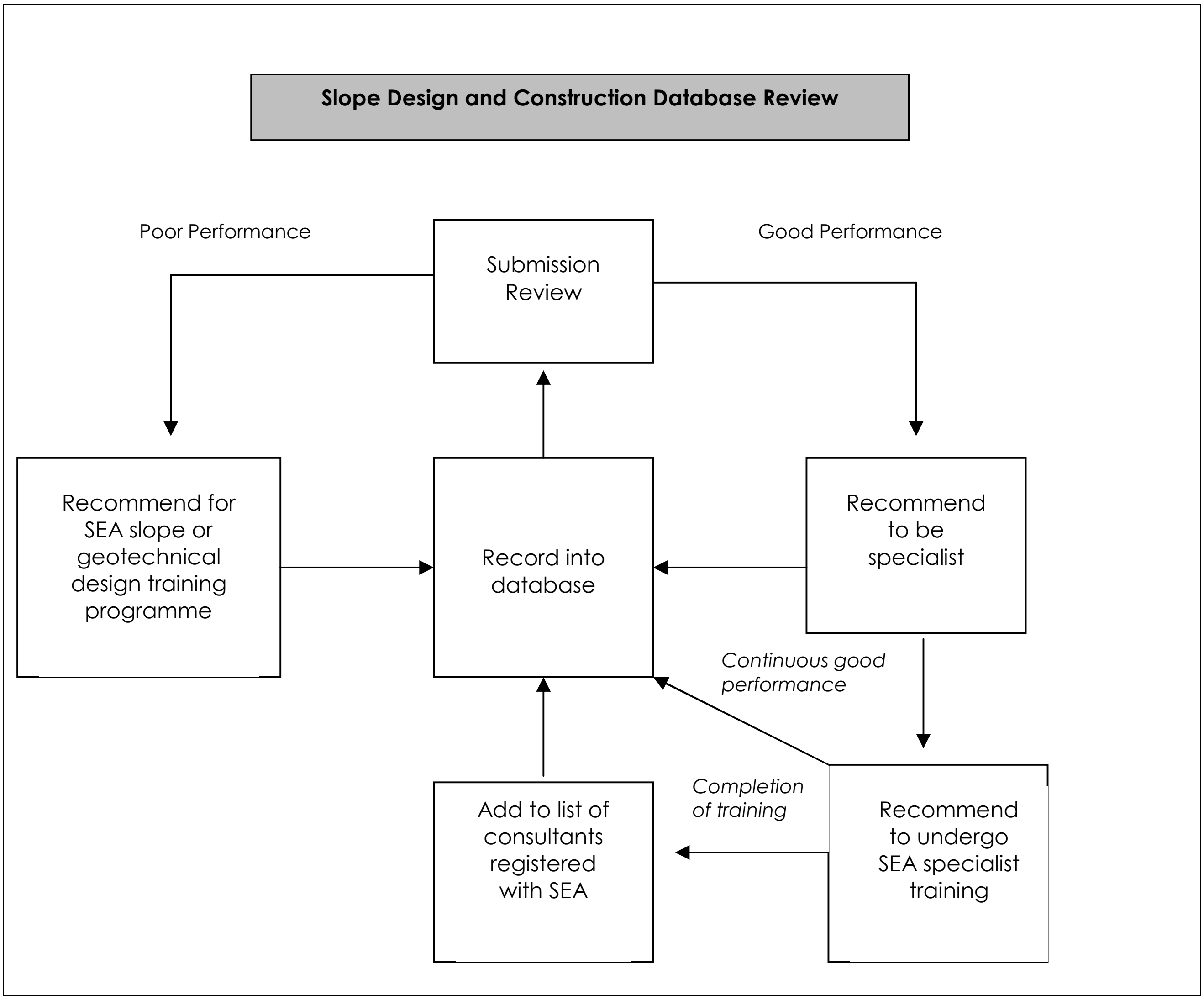


Figure 8.14: Process flow for slope design and construction database review.

8.3.6 Develop a National Plan for Landslide Mitigation Technologies

At present there are sufficient technologies available in Malaysia to prevent a landslide from occurring if the potential danger was spotted or identified with sufficient time for mitigation measures to be implemented. However the probability of spotting a potential landslide and taking mitigation action is very low. Hence, many landslides occur without warning and cause huge losses to properties, economy and lives. These uncertainties have led many researchers and government organisations to conduct research on how to predict the occurrence of landslide as part of loss reduction measures.

The development in information technology could play a major role in providing or integrating the state- of-the- art technology needed to analysis, predict and respond to potential landslide event.

Hence there is a great necessity to integrate information currently available from various agencies such as JUPEM, JPS, JMG, SMART, MACRES, JAS, and PLUS to create a centralised slope database. The key elements of the proposed slope database are

i. Management of slope
ii. Landslide risk analysis
iii. Potential landslide prediction
iv. Response to landslide event

Figure 8.15 shows the proposed slope database integration for loss reduction.

i) Current Slope or Landslide Database

At present the communication and information exchange between government organisations, universities and private bodies have not been established to create a national slope or landslide database. Hence it is relatively difficult to evaluate and prioritise landslide prevention works and encourage cooperation with other organisations for searching and managing paper documents and electronic data. The current principal method of exchanging information during emergencies is telephone and facsimile.

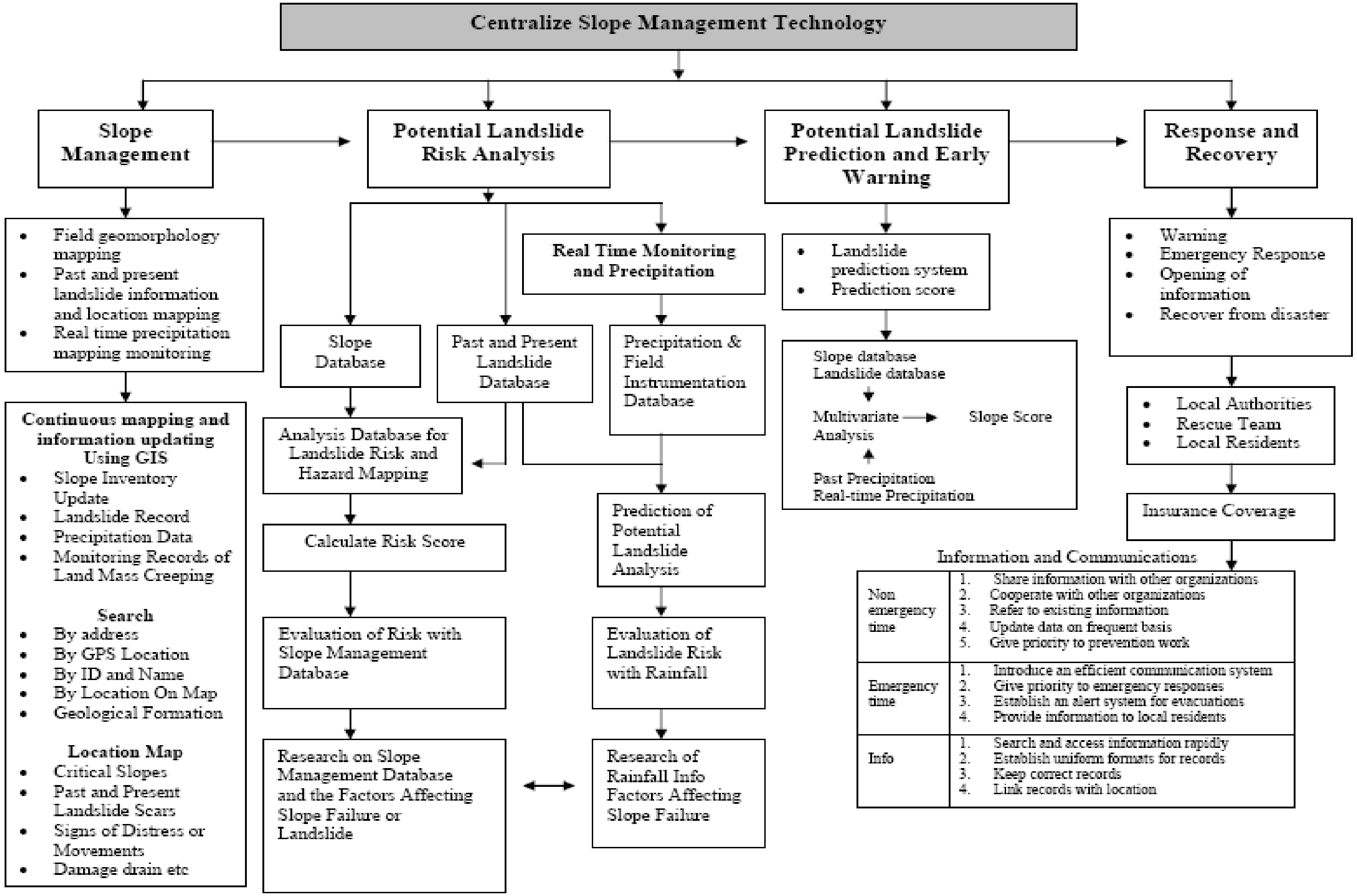


Figure 8.15: Proposed slope database integration loss reduction measures and landslide preventive measures.

It is important to develop a centralised landslide mitigation technology that is accessible by various government bodies, universities and selected private organisations to update, review, analyse and predict potential landslides initiate the early warning system and respond accordingly. It is also proposed to used the advancement in information technology and the Malaysia's "e-government" initiative to rapidly increase the number of information system and types of spatial data available. By integrating the spatial information on areas at risk of landslides using a web-based Geographical Information System (web GIS) with interactive smart maps, database and precipitation data, the ability to predict landslides can be enhanced.

ii) Slope or Landslide Database

The rapid expansion of urban areas and the lack of manpower within the local government to monitor and establish adequate protection against disasters have caused many people to live in the shadow of landslides as reported by the Remote Sensing Agency (MACRES) in a newspaper article on 3rd December 2007 in News Straits Times. This calls for the implementation of more rigorous structural solutions as well as non-structural solutions such as the establishment of early warning and evacuation system, stringent regulations on structures and financial aid to relocate residents from areas of high risk. Due to the complexity of landslide events it is proposed to create a centralised slope or landslide database using field inspection records and spatial data.

a. Management of Slope

The slope or landslide database should comprise information on slope management which consist of field surveyed slope information, past and present landslide information with incorporation of past and real time precipitation monitoring records. The information collected are required to be updated continuously in order to integrate with landslide potential risk, prediction and respond team, who will utilize the database regularly. Under the slope management scope of works it is critical to conduct continuous examination of slope and information updating such as

- Slope inventor
- Past and present landslides
- Monitoring records of creeping land mass

- Real-time updating of precipitation data

The information present in the database is also required to be extracted in a user friendly manner. As such the research result of a particular slope is required to have the following information;

- Address of slope, by street name, land lot numbers, etc.
- Slope identification number and name, given as per GPS coordinates.
- Location of slope is identified in an interactive map, similar to Google map.

Along with the slope information, continuous pop up menu or blinking red spots on aerial maps indicating hazardous and high risk slopes for continuous observation, are required to be shown in the overall map. The information shown should consist of,

- Areas of critical slopes
- Location of past and present landslide scars at highly populated areas
- Areas showing signs of distress and movement

The data input and processed within the slope management database are required to be analysed further for land slide risk factor.

b. Landslide Risk Analysis

Under the landslide risk analysis the various information are analysed and processed in order to compute the risk factor involved. The information of slope from slope database are analysed for landslide risk and hazards mapping to compute the risk score factors. Information of past and present landslide reports which are pre-recorded in the database are also taken into consideration for risk score factor analysis. The computed risk score are then evaluated with slope information and location to install early warning system or advice the local authorities on the risks involved.

In line with slope information analysis, real time field slope instrumentation monitoring data, real time precipitation monitoring data, past slope instrumentation monitoring and precipitation data are input into a computation modal to evaluated the potential risk factor. These computed risk factor can be used to predict potential landslide together with landslide risk with rainfall.

Finally in order to enhance the ability to evaluate the risk and potential landslide, research and development are encouraged in areas of

- Slope information and the factors affecting slope failures
- Rainfall information and the factors affecting slope failures

c. Potential Landslide Prediction

In order to enhance further the landslide risk analysis and the computed risk scores, it is important to utilize the scores to perform landslide prediction exercise.

In order to conduct the prediction, a landslide prediction computational model and the system required to be established by integrating past and present landslide records together with landslide prediction results. The computation model should consist and integrate information such as

- Slope field inspection records and spatial data
- Past and present landslide information with characteristics of slope failures
- Past, present and real time precipitation data with characteristics of slope failures.

This information are analysed further using a multivariate model, which required to be an evolving model, that need be constantly formulated and modified in order to derive much accurate slope scores which would be able to perform realistic landslide prediction.

Integrated research and development is required between database of management of slope, landslide risk analysis and potential landslide prediction assessment in order to obtain much reliable prediction results. Where the results can be used to send out credible early warning to the emergency respond team, public and prevent lost of life, properties, economy etc.

d. Response to Landslide

Quick respond to landslide is vital in order to safe life. Placing proper warning system at strategic places could safe life, properties and also easy the response required to prevent potential landslide.

Similarly emergency response team are required too be well informed and trained in handling landslide events, Information to the public are required to be sent out as soon as to

- Avoid traffic disorder
- Avoid panic
- Public cooperation
- Public contribution to the victim

The above will easy the emergency respond team. Information could also be shared with the local authorities, rescue teams and local residents via web portal. Compensating the victims by means of temporary shelter, financial assistance could be vital for the continuity of their daily activity and the children's education. Hence it is proposed to create Malaysian Landslide Insurance coverage by the federal government to compensate the victims to minimise their losses.

iii) Information and Communication

Information and communication is vital in order to perform effective mitigation measures as part of the government's afford to reduce losses due to landslides. Information and communication can be subdivided into three situations namely

- Non emergency situation
- Emergency situation
- Information sharing

a. Non Emergency Situation

Under the non emergency situation SEA is required to

- Share information with other organisation in term of landslide prevention, mitigation requirement and locations of high risk and hazardous.
- Cooperate with other organisation to collect and analysis information such as rainfall records, soil or geological information, topography of the site, etc.
- Refer to existing information available and update database regularly and make those information accessible to other agency.
- Give or set priority to landslide prevention works by creating or building buffer zones or by enhancing the stability of slopes.

b. Emergency Situation

During emergency it is vital to introduce or create or use a single mode of effective communication system. SEA will be required to set priorities and plan the emergency responses accordingly. In the event a potential landslide was identified by means of on site installed early warning system, it is critical for SEA to establish a suitable alert or early warning system for evacuations. The process of evacuations is required to be well coordinated and supervised by relevant authorities such as The Police and Bomba. All relevant information during the emergency situation are required to be made available to the local residents seeking for missing relatives.

iv) Information and Communication as Mitigation Technology

As information being the most critical element in today's technology it is best to , enhance the current mitigation technology available using information technology. Hence searching and accessing information rapidly is vital as part of loss reduction measures. In order to access information rapidly it is important to establish uniform formats for record and establish uniform standards for records keeping, nation wide. Creating communication links between emergency response agencies and technical agencies should be made as part of information sharing exercise in order to enhance landslide mitigation technology as part of loss reduction measures.

8.4 Recommended Strategies

Successful loss reduction programme will be based on effective application of landslide information at federal, state and local levels. Detail research programmes and additional assistance measures are needed to ensure that such loss reduction strategies are in fact used by state and local agencies and private entities.

8.4.1 Introduction

Successful loss reduction strategies should include mitigation measures under taken by state and local agencies, developers and individuals. A range of mitigation measures proposed includes improvement to land use planning and local regulations, engineering and building codes of practice review, professional incentives and disincentives scheme for developer, engineers and contractors and also points out the impediments for improvement.

8.4.2 Strategies Thrust

Systematic approaches to the identified hazards, factors and selection of appropriate loss reduction measures at local level throughout the country in order to reduce losses due to slope failure is the main strategic under the component of loss reduction measures. Five key strategy thrusts were identified for loss reduction measures as listed in **Table 8.5.**

Table 8.5: Strategic Thrusts

Strategic Thrust	Strategies
Loss Reduction Measures Implement a systematic approach to identify factors and hazards related to slope failures and select appropriate loss and landslide preventive measures	8.1 Remove various impediments for effective implementation of current legal framework. 8.2 Introduce the participation of SEA at various stages of devolvement and construction approval. 8.3 Develop and implement a detailed framework for planning, design, construction, maintenance and landslide preventive measures for slopes. 8.4 Implement framework of incentives and disincentives for developers, engineers and contractors to encourage landslide mitigation works. 8.5 Develop a national plan to adopt landslide mitigation technology

As loss reduction measures covers a wide spectrum, strategic covering sectors such as legal, education, R & D, and hazard mapping are listed at the strategic thrust of the relevant components.

8.4.3 Strategies

Strategy 8.1	Remove various impediments for effective implementation of current legal framework

The approval for a development orders, are governed by various guidelines. The primary functions of the guidelines are to ensure that the slope or walls are constructed in accordance to specifications and regulation.

List of Actions

8.1.1 Increase in work force for guideline implementation would ease the implementation process effectively

8.1.2 Setup and create a working team of well trained personnel to standardise nation-wide development regulation

8.1.3 Perform regular standard and guideline reviews and updates

Strategy 8.2	Introduce the participation of SEA at various stages of development and construction approval

In order to develop a national plan for improvement on loss reduction measures, studies and interviews were conducted with local and the relevant authorities. From the survey it is recommended to take preventive measures at the early stages of a development process. Hence, it is proposed to incorporate loss reduction measures at various level of development process by the local authorities, together with SEA involvement.

List of Actions

8.2.1 Create team of experienced checkers for development plan processing for local authorities and SEA

8.2.2 Get SEA involved at various stages of the development approval process

Strategy 8.3	Develop and implement a detailed framework for planning, design, construction, maintenance and landslide preventive measures for slopes

In order to derive at a feasible framework as part of new guideline under loss reduction measures, the process flow of land development such as planning, application, approval, design, construction, maintenances and landslide preventive measures of slopes need to be identified and fine turned to enforce loss reduction measures. Hence loss reduction measures need to be taken into consideration at every stage of development systematically.

List of Actions

8.3.1 Implement effectively the loss reduction measures available within the current framework

8.3.2 Create a checklist to verify the planning, design, construction, maintenance and landslide preventive measures for slope as per SEA's requirement

Strategy 8.4	Implement framework of incentive and disincentive for developers, engineers and contractors to encourage landslide mitigation works.

In order to develop a programme which would create awareness and motivation to deliver reliable and safe slope design by engineers as part of nation wide loss reduction measure, an integrated national slope design, construction and maintenance system is required.

List of Actions

8.4.1 Create guidelines and set of rules and regulations to be implemented as part of incentive and disincentive scheme

8.4.2 Create and development application system database to monitor engineers and developers

Strategy 8.5	Develop a national plan to adopt landslide mitigation technology

The development in information technology would play a major role in providing or integrating the state- of-the- art technology needed to manage analysis, predict and respond to potential landslide event in order to minimise the losses.

List of Actions

8.5.1 Create the state- of-the- art centralise slope Management Technology

8.5.2 Perform field surveys to collect information related to slope and geomorphology

8.4.4 Summary

Table 8.6: Action Plans

Strategy	Action Plans
8.1 Remove various impediments for effective implementation of current legal framework	**8.1.1 Increase in manpower for guideline implementation to ease the implementation process** An increase will contribute effective data processing and management. **8.1.2 Set up and create a working team of well-trained personnel to standardise development regulation.** There must be a team of will-trained personnel to standardise development regulation. **8.1.3 Perform regular standard and guideline reviews and updates** A working committee consisting of experienced engineers, policy makers and administrators to consistently review and update the guidelines to remove impediments and make the necessary changes in government policies..
8.2 Introduce the participation of SEA at various stages of development and construction	**8.2.1 Create a team of experienced checkers for development plan processing for local authorities and SEA** Experienced geotechnical and geological checkers could contribute widely in the reviewing and fine tuning slope engineering works in large-scale development project. **8.2.2 Get SEA involved at various stages of the development approval process.** The participation of SEA to advise local authorities could further enhance the quality of development with well engineered slopes. Early involvement of SEA in the development planning process could minimize environmental damage, and risks and reduce potential cost increase during construction.

Strategy	Action Plans
8.3 Develop and implement a detailed framework for planning, design, construction, maintenance and landslide preventive measures for slopes	**8.3.1 Implement effectively the loss reduction measures available within the current framework** At present, there are sufficient embedded clauses that can be implemented at various stages of development, which can be used to effectively reduce losses due to slope failures. Hence systematic planning and implementation of these clauses need to be emphasised. **8.3.2 Create a checklist to verify the planning, design, construction, maintenance and landslide preventive measures for slopes** To ease the verification process, it would be appropriate for SEA to have a well structured checklist to assist the engineers involved in the verification process. The checklist should be detailed enough to highlight any inadequacies in the development process which do not comply with code of practice and the legal frameworks involved. Along with a detailed checklist implementation of planning, design, construction and maintenance SEA must also implement landslide preventive measures.
8.4 Implement a framework of incentives and disincentives for developers, engineers and contractors to encourage landslide mitigation works	**8.4.1 Create guidelines and set of rules and regulations to be implemented as part of an incentive and disincentive scheme** Creation of guidelines and well-planned incentive and disincentive scheme would ensure the quality of works delivered by engineers involved in slope engineering works. **8.4.2 Create and development application system database to monitor engineers and developers** A centralized database to monitor the development application process would facilitate the planning process. This would also facilitate SEA's input to the local authorities during the development process application review.

Strategy	Action Plans
8.5 Develop a national plan to adopt landslide mitigation technology	**8.5.1 Create a state-of-the -art centralised slope management technology** The proposed slope management system would provide a view of all the areas with slopes that require immediate attention. This would indirectly contribute to easier decision making when local authorities refer to SEA's advice. **8.5.2 Perform field surveys to collect information related to slope and geomorphology** A slope information database together with geomorphology maps will assist SEA in decision making and will serve as a common point of reference in discussions with other agencies and local authorities. A field survey database will also contribute to early preventive measures that can be implemented before failures take place.

8.5 Implementation Framework and Plan

8.5.1 Introduction

In order to implement the above strategies a well-planned implementation framework is required.

8.5.2 Implementation Process

The proposed strategies are required to be implemented concurrently, and the link between each stages as shown under implementation structure.

8.5.3 Implementation Structure

The key players for implementation are SEA, the Ministry of Works, local authorities and other relevant agencies.

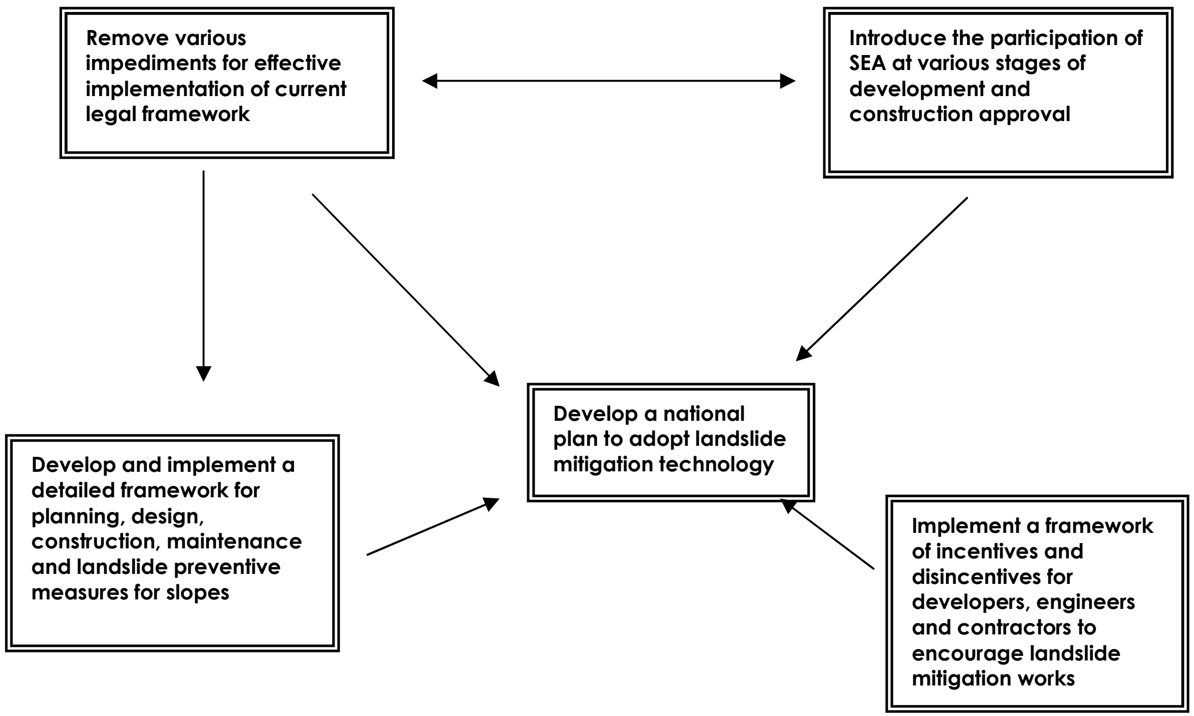


Figure8.16: Flowchat for Implementation process

Implementation structure

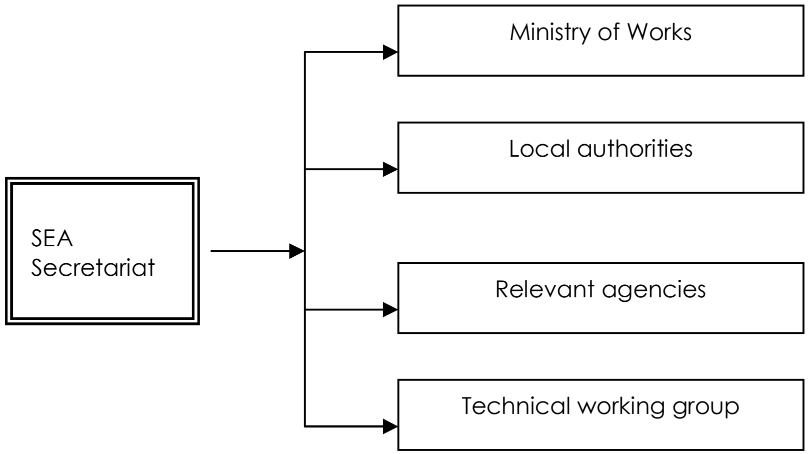


Figure 8.17: Implementation structure

8.5.4 Strategy Implementation Framework

Table 8.7 : Action plan implementation for loss reduction measures

No.	Action Plan	Who	When/Cost (RM Million)			
			Phase 1		Phase 2	Phase 3
			(2009 – 2010)	(2011 – 2013	(2014 – 2018)	(2019 – 2023)
8.1	**Remove various impediments for effective implementation of current legal framework**					
8.1.1	Increase in man power for guideline implementation would ease the implementation process eff	Local authorities, CKC/SEA, JMG, JLN, JUPEM, JPP, JAS, JPS, JPBD, MKN, CIDB, SIRIM	0.3	0.4	0.4	0.5
8.1.2.	Set up and create a working team of well-trained personnel to standardise development regulation	Local authorities, CKC/SEA, JMG, JLN, JUPEM, JPP, JAS, JPS, JPBD. MKN, CIDB, MACRES	0.2	0.3	0.3	0.4
8.1.3	Perform regular standard and guideline reviews and updates	Local Authorities, CKC/SEA, JMG, JLN, JUPEM, JPP, JAS, JPS, JPBD, MKN, CIDB, MACRES	0.2	0.3	0.3	0.4

8.2	**Introduce the participation of SEA at various stages of development and construction approval**					
8.2.1	Create a team of experienced checkers for development plan processing for local authorities and SEA	Local authorities, CKC/SEA	0.3	0.9	1.2	1.2
8.2.2	Get SEA involved at various stage of development approval process	Local authorities, CKC/SEA,	0.2	0.6	0.8	0.8
8.3	**Develop and implement a detailed framework for planning, design, construction and maintenance of slope**					
8.3.1	Implement effectively the loss reduction measures available within the current framework	CKC/SEA	0.3	0.4	0.4	0.5
8.3.2	Create a checklist to verify the planning, design, construction maintenance, for slopes and landslide preventive measures	Local authorities, CKC/SEA, CIDB	0.3	0.3	0.3	0.4
8.4	**Implement a framework of incentive and disincentives for developers, engineers and contractors to encourage landslide mitigation works**					
8.4.1	Create guideline and set of rules and regulations to be implemented as part of an incentive and disincentive scheme.	Local authorities, CKC/SEA, CIDB, SIRIM	1.0	0.6	0.4	0.4
8.4.2	Create and develop application system database to monitor engineers and developers	Local authorities, CKC/SEA, JMG, JLN, JUPEM, JPP, JAS, JPS, JPBD. MKN, CIDB, SIRIM	1.0	0.6	0.4	0.6

8.5	Develop a national plan to adopt landslide mitigation technology					
8.5.1	Create a state-of-the-art centralised slope management and technology	Local authorities, CKC/SEA, JMG, JLN, JUPEM, JPP, JAS, JPS, JPBD, MKN, CIDB, SIRIM	1.5	0.6	0.8	0.8
8.5.2	Perform field surveys to collect information related to slope and geomorphology	Local authorities, CKC/SEA, CIDB	3.0	1.5	0.8	0.8
		Sub Total	8.3	6.5	6.1	6.8
		Total	27.7			

8.5.5 Key Performance Indicators

The key performance indicators are mainly identified by the reduction of major landslide events. Under loss reduction measures, the key performance indicators be the establishment of well-organised, planned and control hill land construction works, the active involvement of the private sector in landslide mitigation works and finally the adoption of landslide mitigation technology to reduce the number of failure events. The number of landslides events reported in the Loss Assessment component report was 441 between the years 1961 to 2007 with a total estimated loss of RM2.5 billion. This gives an annual average of 13 landslides with annual loss of about 76 million. These numbers are proposed to be baseline for the key performance indicators.

Table 8.8 : Key performance indicators for loss reduction measures

Critical Success Factors	Key Performance Indicators	Target		
		Phase 1	Phase 2	Phase 3
Guidelines	Well- organised, planned and controlled construction works as per code of practise and international standards, for reducing failures due to development works	40%	60%	70%
Rewards	The active participation of the private sector in landslide mitigation and preventive works as per SEA's requirement, observed by the number of rewards given on quality and safe slope engineering work done	30%	50%	70%
Technology	Reduction of disastrous landslide events with the use of advanced slope failure mitigation technology nationwide	20%	60%	80%

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APPENDIX 1

TECHNICAL TERMS AND LIST OF MAJOR LANDSLIDES

I) GLOSSARY

The ISDR Secretariat presents these basic definitions on disaster risk reduction in order to promote a common understanding on this subject, for use by the public, authorities and practitioners. The terms are based on a broad consideration of different international sources (*source: www.unisdr.org*).

Keyword	Description
Acceptable risk	The level of loss a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions. *In engineering terms, acceptable risk is also used to assess structural and non-structural measures undertaken to reduce possible damage at a level which does not harm people and property, according to codes or "accepted practice" based, among other issues, on a known probability of hazard.*
Building codes	Ordinances and regulations controlling the design, construction, materials, alteration and occupancy of any structure to insure human safety and welfare. Building codes include both technical and functional standards.
Capacity	A combination of all the strengths and resources available within a community, society or organization that can reduce the level of risk, or the effects of a disaster. *Capacity may include physical, institutional, social or economic means as well as skilled personal or collective attributes such as leadership and management. Capacity may also be described as capability.*
Capacity building	Efforts aimed to develop human skills or societal infrastructures within a community or organization needed to reduce the level of risk. *In extended understanding, capacity building also includes development of institutional, financial, political and other resources, such as technology at different levels and sectors of the society.*
Climate change	The climate of a place or region is changed if over an extended period (typically decades or longer) there is a statistically significant change in measurements of either the mean state or variability of the climate for that place or region. *Changes in climate may be due to natural processes or to persistent anthropogenic changes in atmosphere or in land use. Note that the definition of climate change used in the United Nations Framework Convention on Climate Change is more restricted, as it includes only those changes which are attributable directly or indirectly to human activity.*
Coping capacity	The means by which people or organizations use available resources and abilities to face adverse consequences that could lead to a disaster. *In general, this involves managing resources, both in normal times as well as during crises or adverse conditions. The strengthening of coping capacities usually builds resilience to withstand the effects of natural and human-induced hazards.*
Counter measures	All measures taken to counter and reduce disaster risk. They most commonly refer to engineering (structural) measures but can also include non-structural measures and tools designed and employed to avoid or limit the adverse impact of natural hazards and related environmental and technological disasters.
Disaster	A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources. *A disaster is a function of the risk process. It results from the combination of hazards, conditions of vulnerability and insufficient capacity or measures to reduce the potential negative consequences of risk.*
Disaster risk management	The systematic process of using administrative decisions, organization, operational skills and capacities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural hazards and related environmental and technological disasters. This comprises all forms of activities, including structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of hazards.

Disaster risk reduction (disaster reduction)	The conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development.
Early warning	The provision of timely and effective information, through identified institutions, that allows individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response. *Early warning systems include a chain of concerns, namely: understanding and mapping the hazard; monitoring and forecasting impending events; processing and disseminating understandable warnings to political authorities and the population, and undertaking appropriate and timely actions in response to the warnings.*
El Niño-southern oscillation (ENSO)	A complex interaction of the tropical Pacific Ocean and the global atmosphere that results in irregularly occurring episodes of changed ocean and weather patterns in many parts of the world, often with significant impacts, such as altered marine habitats, rainfall changes, floods, droughts, and changes in storm patterns. *The El Niño part of ENSO refers to the well-above-average ocean temperatures along the coasts of Ecuador, Peru and northern Chile and across the eastern equatorial Pacific Ocean, while the Southern Oscillation refers to the associated global patterns of changed atmospheric pressure and rainfall. La Niña is approximately the opposite condition to El Niño. Each El Niño or La Niña episode usually lasts for several seasons.*
Emergency management	The organization and management of resources and responsibilities for dealing with all aspects of emergencies, in particularly preparedness, response and rehabilitation. *Emergency management involves plans, structures and arrangements established to engage the normal endeavours of government, voluntary and private agencies in a comprehensive and coordinated way to respond to the whole spectrum of emergency needs. This is also known as disaster management.*
Environmental impact assessment (EIA)	Studies undertaken in order to assess the effect on a specified environment of the introduction of any new factor, which may upset the current ecological balance. *EIA is a policy making tool that serves to provide evidence and analysis of environmental impacts of activities from conception to decision-making. It is utilised extensively in national programming and for international development assistance projects. An EIA must include a detailed risk assessment and provide alternatives solutions or options.*
Environmental degradation	The reduction of the capacity of the environment to meet social and ecological objectives, and needs. *Potential effects are varied and may contribute to an increase in vulnerability and the frequency and intensity of natural hazards.* *Some examples: land degradation, deforestation, desertification, wildland fires, loss of biodiversity, land, water and air pollution, climate change, sea level rise and ozone depletion.*
Forecast	Definite statement or statistical estimate of the occurrence of a future event (UNESCO, WMO).
Geological hazard	Natural earth processes or phenomena that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. *Geological hazard includes internal earth processes or tectonic origin, such as earthquakes, geological fault activity, tsunamis, volcanic activity and emissions as well as external processes such as mass movements: landslides, rockslides, rock falls or avalanches, surfaces collapses, expansive soils and debris or mud flows.* *Geological hazards can be single, sequential or combined in their origin and effects.*
Geographic information systems (GIS)	Analysis that combine relational databases with spatial interpretation and outputs often in form of maps. A more elaborate definition is that of computer programmers for capturing, storing, checking, integrating, analyzing and displaying data about the earth that is spatially referenced. *Geographical information systems are increasingly being utilized for hazard and vulnerability mapping and analysis, as well as for the application of disaster risk management measures.*
Greenhouse gas (GHG)	A gas, such as water vapour, carbon dioxide, methane, chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), that absorbs and re-emits infrared radiation, warming the earth's surface and contributing to climate change (UNEP, 1998).

Hazard	A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. *Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydrometeorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterised by its location, intensity, frequency and probability.*
Hazard analysis	Identification, studies and monitoring of any hazard to determine its potential, origin, characteristics and behaviour.
Hydrometeo-rological hazards	Natural processes or phenomena of atmospheric, hydrological or oceanographic nature, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. *Hydrometeorological hazards include: floods, debris and mud floods; tropical cyclones, storm surges, thunder/hailstorms, rain and wind storms, blizzards and other severe storms; drought, desertification, wildland fires, temperature extremes, sand or dust storms; permafrost and snow or ice avalanches. Hydrometeorological hazards can be single, sequential or combined in their origin and effects.*
La Niña	(see El Niño-Southern Oscillation).
Land-use planning	Branch of physical and socio-economic planning that determines the means and assesses the values or limitations of various options in which land is to be utilized, with the corresponding effects on different segments of the population or interests of a community taken into account in resulting decisions. *Land-use planning involves studies and mapping, analysis of environmental and hazard data, formulation of alternative land-use decisions and design of a long-range plan for different geographical and administrative scales.* *Land-use planning can help to mitigate disasters and reduce risks by discouraging high-density settlements and construction of key installations in hazard-prone areas, control of population density and expansion, and in the siting of service routes for transport, power, water, sewage and other critical facilities.*
Mitigation	Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards.
Natural hazards	Natural processes or phenomena occurring in the biosphere that may constitute a damaging event. *Natural hazards can be classified by origin namely: geological, hydrometeorological or biological. Hazardous events can vary in magnitude or intensity, frequency, duration, area of extent, speed of onset, spatial dispersion and temporal spacing.*
Nowcasting	The detailed description of the current weather along with forecasts obtained by extrapolation up to about 2 hours ahead. Any area-specific forecast for the period up to 12 hours ahead that is based on very detailed observational data. *(Additional definition to ISDR's basic definitions)*
Preparedness	Activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warnings and the temporary evacuation of people and property from threatened locations.
Prevention	Activities to provide outright avoidance of the adverse impact of hazards and means to minimize related environmental, technological and biological disasters. *Depending on social and technical feasibility and cost/benefit considerations, investing in preventive measures is justified in areas frequently affected by disasters. In the context of public awareness and education, related to disaster risk reduction changing attitudes and behaviour contribute to promoting a "culture of prevention".*
Public awareness	The processes of informing the general population, increasing levels of consciousness about risks and how people can act to reduce their exposure to hazards. This is particularly important for public officials in fulfilling their responsibilities to save lives and property in the event of a disaster. *Public awareness activities foster changes in behaviour leading towards a culture of risk reduction. This involves public information, dissemination, education, radio or television broadcasts, use of printed media, as well as, the establishment of information centres and networks and community and participation actions.*
Public information	Information, facts and knowledge provided or learned as a result of research or study, available to be disseminated to the public.

Recovery	Decisions and actions taken after a disaster with a view to restoring or improving the pre-disaster living conditions of the stricken community, while encouraging and facilitating necessary adjustments to reduce disaster risk. *Recovery (rehabilitation and reconstruction) affords an opportunity to develop and apply disaster risk reduction measures.*
Relief / response	The provision of assistance or intervention during or immediately after a disaster to meet the life preservation and basic subsistence needs of those people affected. It can be of an immediate, short-term, or protracted duration.
Resilience / resilient	The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures.
Retrofitting (or upgrading)	Reinforcement of structures to become more resistant and resilient to the forces of natural hazards. *Retrofitting involves consideration of changes in the mass, stiffness, damping, load path and ductility of materials, as well as radical changes such as the introduction of energy absorbing dampers and base isolation systems. Examples of retrofitting includes the consideration of wind loading to strengthen and minimize the wind force, or in earthquake prone areas, the strengthening of structures.*
Risk	The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions. *Conventionally risk is expressed by the notation* *Risk = Hazards x Vulnerability. Some disciplines also include the concept of exposure to refer particularly to the physical aspects of vulnerability.* *Beyond expressing a possibility of physical harm, it is crucial to recognize that risks are inherent or can be created or exist within social systems. It is important to consider the social contexts in which risks occur and that people therefore do not necessarily share the same perceptions of risk and their underlying causes.*
Risk assessment /analysis	A methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend. *The process of conducting a risk assessment is based on a review of both the technical features of hazards such as their location, intensity, frequency and probability; and also the analysis of the physical, social, economic and environmental dimensions of vulnerability and exposure, while taking particular account of the coping capabilities pertinent to the risk scenarios.*
Structural / non-structural measures	Structural measures refer to any physical construction to reduce or avoid possible impacts of hazards, which include engineering measures and construction of hazard-resistant and protective structures and infrastructure. *Non-structural measures refer to policies, awareness, knowledge development, public commitment, and methods and operating practices, including participatory mechanisms and the provision of information, which can reduce risk and related impacts.*
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs. (Brundtland Commission, 1987). *Sustainable development is based on socio-cultural development, political stability and decorum, economic growth and ecosystem protection, which all relate to disaster risk reduction.*
Vulnerability	The conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards. *For positive factors, which increase the ability of people to cope with hazards, see definition of capacity.*

II) DESCRIPTION OF LANDSLIDE FEATURES

The morphology of landslide were first described by Cruden & Varnes (1996) and are presented in **Figure 1**.

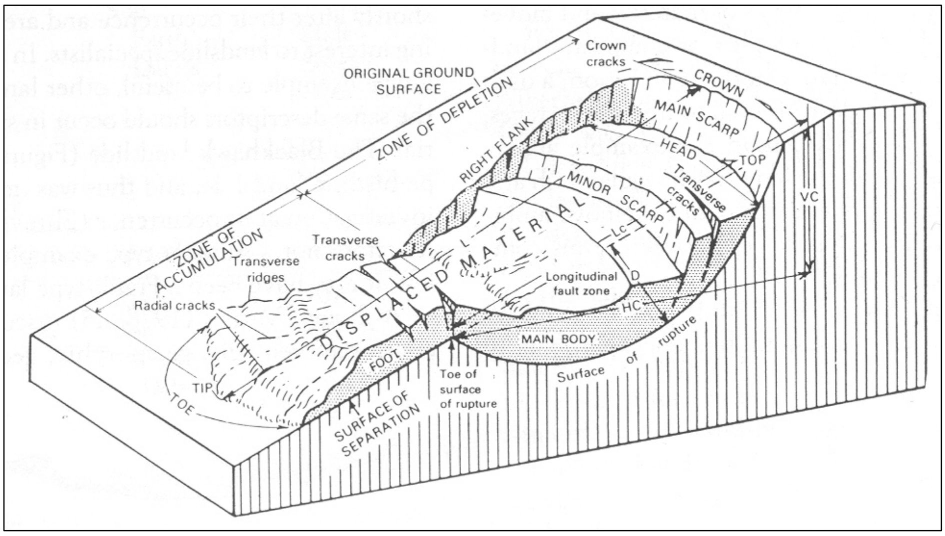
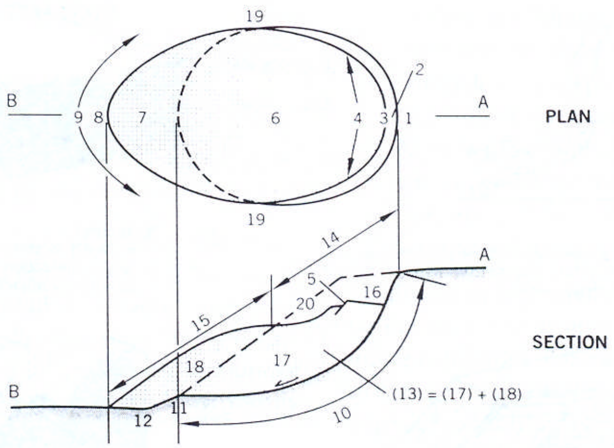


Figure 1: Terminology for Describing Landslide Features (Cruden & Varnes, 1996)

However, the International Association of Engineering Geologists (IAEG) created a Commission on Landslides that has subsequently made minor modifications and was reproduced in **Figure 2**. As can be seen from **Figure 2**, the elevation of the ground surface decreases as a result of landsliding in the *zone of depletion* while the elevation of the ground surface increases in the *zone of accumulation* (Cornforth, 2005).



No.	Name	Definition
1	Crown	Practically undisplaced material adjacent to highest parts of main scarp
2	Main scarp	Steep surface on undisturbed ground at upper edge of landslide caused by movement of displaced material (13, stippled area) away from undisturbed ground; it is a visible part of surface of rupture (10)
3	Top	Highest point of contact between displaced material (13) and main scarp (2)
4	Head	Upper parts of landslide along contact between displaced material and main scarp (2)
5	Minor scarp	Steep surface on displaced material of landslide produced by differential movements within displaced material
6	Main body	Part of displaced material of landslide that overlies surface of rupture between main scarp (2) and toe of surface of rupture (11)
7	Foot	Portion of landslide that has moved beyond toe of surface of rupture (11) and overlies original ground surface (20)
8	Tip	Point on toe (9) farthest from top (3) of landslide
9	Toe	Lower, usually curved margin of displaced material of a landslide, most distant from main scarp (2)
10	Surface of rupture	Surface that forms (or that has formed) lower boundary of displaced material (13) below original ground surface (20); also termed *slip surface* or *shear surface*; if planar, can be termed *slip plane* or *shear plane*
11	Toe of surface of rupture	Intersection (usually buried) between lower part of surface of rupture (10) of a landslide and original ground surface (20)
12	Surface of separation	Part of original ground surface (20) now overlain by foot (7) of landslide
13	Displaced material	Material displaced from its original position on slope by movement in landslide; comprises both depleted mass (17) and accumulation (18)
14	Zone of depletion	Area of landslide within which displaced material lies below original ground surface (20)
15	Zone of accumulation	Area of landslide within which displaced material (13) lies above original ground surface (20)
16	Depletion	Volume bounded by main scarp (2), depleted mass (17), and original ground surface (20)
17	Depleted mass	Volume of displaced material (13) that overlies surface of rupture (10) but underlies original ground surface (20)
18	Accumulation	Volume of displaced material (13) that lies above original ground surface (20)
19	Flank	Undisplaced material adjacent to sides of surface of rupture; if left and right are used, they refer to flanks as viewed from crown; otherwise use compass directions
20	Original ground surface	Surface of slope that existed before landslide took place

Figure 2: Description of Landslide Features (based on UNESCO Working Party,1993, with minor modifications) (Cornforth, 2005)

III) LANDSLIDE CLASSIFICATION

- **Type of Slope**
    - o Natural Slope
    - o Man-made Slope

- **Type of material**
    - o Rock
    - o Predominantly coarse material (debris): Material defined as having 20%-80% of particles in the gravel/boulder size (>2mm) (Huat et. al., 2008)
    - o Predominantly fine material (earth)

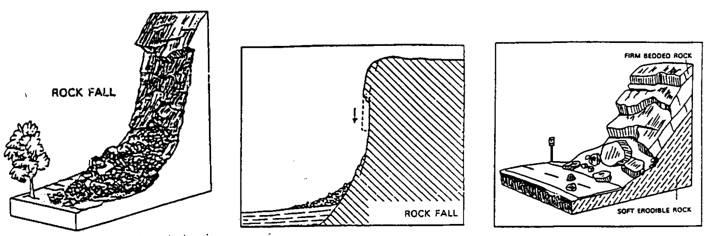
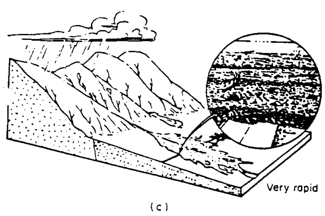
- **Type of Movement**

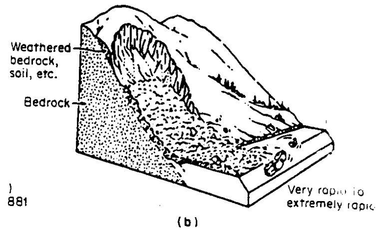
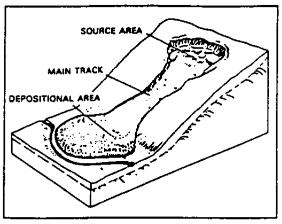
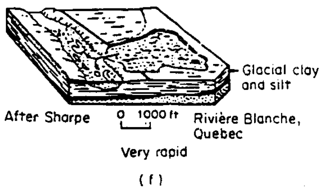
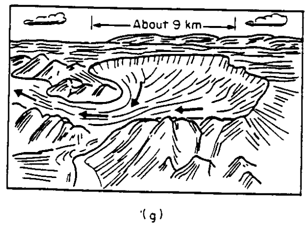
  In the original work by Varnes (1978), Varnes had generally categorized the landslide movement as follows:
    - o Falls
    - o Topples
    - o Slides – rotational and translational
    - o Lateral Spreads
    - o Flows
    - o Combination of types

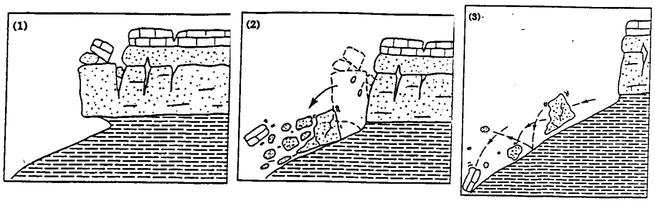
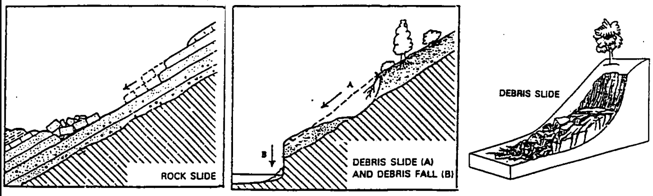
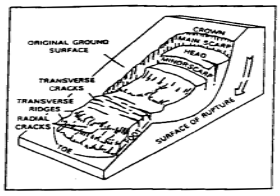
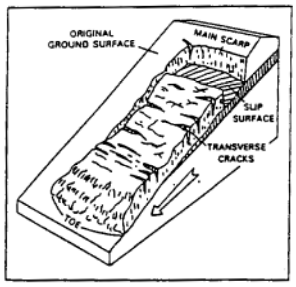
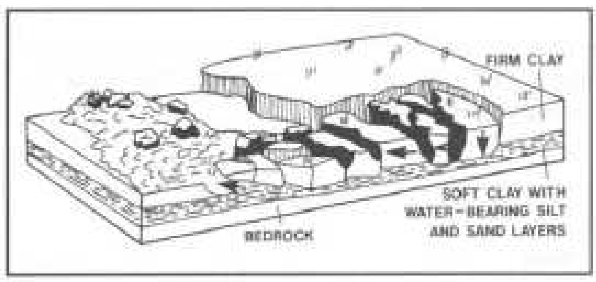
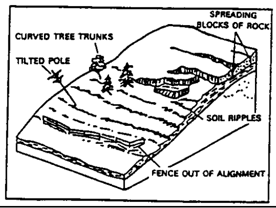
  The category was later updated and being further categorized by Hunt (1984) and Cruden & Varnes (1996).

Table 1: Type of Landslides Movement

(compiled and modified from Hunt (1984), Cruden & Varnes (1996))

Type Of Movement	Description	Examples
FALLS	Falls are abrupt movements of masses of geologic materials that become detached from steep slopes or cliffs (i.e., rock fall). Movement occurs by free fall, bouncing and rolling. Depending on the type of earth materials involved, the result is a rock fall, soil fall, debris fall, earth fall, boulder fall and so on. All types of falls are promoted by undercutting, differential weathering, excavation or stream erosion.	
FALLS (Debris Flow)	A debris flow is a form of rapid mass movement in which loose soils, rocks and organic matter combined with entrapped air and water to form a slurry that then flows down-slope. Debris flow areas are usually associated with steep gullies. Individual debris flow areas can usually be identified by the presence of debris fans at the termini of the drainage basins.	

FALLS (Debris Avalanche)	A variety of very rapid to extremely rapid debris flow	
FALLS (Earth Flow)	Earth flows have a characteristic "hour glass" shape. A bowl of depression forms at the head where the unstable material collects and flows out. The central area is narrow and usually becomes wider as it reaches the valley floor. Flows generally occur in fine-grained materials clay-bearing rocks on moderate slopes and with saturated conditions. However, dry flows of granular material are also possible.	
FALLS (Mud Flow)	An earth flow that consists of material that is wet enough to flow rapidly and that contains at least 50% sand, silt- and clay- sized particles.	
FALLS (Lahar)	A mud flow or debris flow that originates on a slope of a volcano. Lahars are usually triggered by such things as heavy rainfall eroding volcanic deposits; sudden melting of snow and ice due to heat from volcanic vents; or by the breakout of water from glaciers, crater lakes, or lakes dammed by volcanic eruptions.	
FALLS (STURZSTROM / Rock Avalanche)	A sturzstrom is caused by a trigger, such as an earthquake or volcano. It moves rapidly, but does not necessarily require water to be present within it to move. Therefore, there is no definite explanation for their movement. The leading theory is that sturzstroms ride on "air cushions", or dust clouds generated by itself. This is called acoustic fluidization. Once moving, it can ride over nearly any terrain. It more often moves over horizontal ground, more than downward-sloped ground. Its momentum can carry it up small hills. Some characteristics of sturzstroms are: ▪ Mass movement of dry rock debris. ▪ Avalanche volume > about 106 cubic meters. ▪ Ratio of fall height to run out length < 0.6. ▪ Mobility of sturzstroms increases with avalanche volume. ▪ Observations suggest sturzstroms "flow" like a fluid *(source: www.en.wikipedia.org)*	

TOPPLES	A topple is a block of rock that tilts or rotates forward on a pivot or hinge point and then separates from the main mass, falling to the slope below, and subsequently bouncing or rolling down the slope.	
SLIDES	A more restrictive use of the term which refers to movements of soil or rock along a distinct surface of rupture which separates the slide material from more stable underlying material. The 2 major types of landslides are rotational slides and translational slides.	
SLIDES (Rotational)	One in which the surface of rupture is curved concavely upwards (spoon shaped) and the slide movement is more or less rotational about the axis that is parallel to the contour of the slope. "Slump" is an example of a small rotational slide.	
SLIDES (Translational)	The mass moves out, or down and outwards along a relatively planar surface and has little rotational movement or backward tilting. The mass commonly slides out on top of the original ground surface. Such a slide may progress over great distances if conditions are right. Slide material may range from loose unconsolidated soils to extensive slabs of rock. A "block slide" is a translational slide in which the moving mass consists of a single unit, or a few closely related units that move down-slope as a single unit.	
LATERAL SPREADS	A result of a nearly horizontal movement of geologic materials and are distinctive because they usually occur on very gentle slopes. The failure is caused by liquefaction, the process whereby saturated, loose, cohesionless sediments (usually sands & silts) are transformed from a solid into a liquefied state. Failure usually triggered by rapid ground motion such as that experienced during earthquake, or by slow chemical changes in the pore water and mineral constituents.	
FLOWS (Creep)	This is the imperceptibly slow, steady downward movement of slope-forming soil and rock. Creep is indicated by curved tree trunks, bent fences or retaining walls, tilted poles or fences, and small soil ripples or terracettes.	

- **Disturbance State of Slope Material (Huat et. al., 2008)**
  - Virgin Landslides: Occur in undisturbed slope materials operating with mobilized peak soil strength.
  - Reactivated Landslides: Occur in disturbed slope materials at a previous landslip area operating with mobilized residual shear strength.

- **Rate of Movement**

Table 2: Velocity Classes for Landslides (after International Geotechnical Societies UNESCO Working Parrty on World Landslide Inventory (WP/WLI, 1995)

Velocity Class	Description	Velocity Limit	Nature of Impact
7	**Extremely Rapid**	5 m/s	Catastrophe of major violence, exposed buildings totally destroyed and population killed by impact of displaced material, or by disaggregation of the displaced mass
6	**Very Rapid**	3 m/min	Some lives lost because the landslide velocity is too great to permit all persons to escape, major destruction
5	**Rapid**	1.8 m/hour	Escape and evacuation possible; structure, possessions and equipment destroyed by the displaced mass
4	**Moderate**	13 m/month	Insensitive structures can be maintained if they are located a short distance in front of the toe of the displaced mass; structures located on the displaced mass are extensively damaged
3	**Slow**	1.6 m/year	Roads and insensitive structures can be maintained with frequent and heavy maintenance work, if the movement does not last too long and if differential movements at the margins of the landslide are distributed across a wide zone
2	**Very Slow**	0.016 m/ year	Some permanent structures undamaged or, if they are cracked by the movement, they can be repaired
1	**Extremely Slow**		No damage to structures built with precautions

In addition, very slow or extremely slow slope movements are often termed as creep

- **Size**

Up to date, there is no available standard to categorize the landslide by size. However, it is relatively useful to provide some guidelines to describe the extent of a landslide. Cornforth (2005) suggested a guideline for such a purpose which is presented in **Table 3**.

Table 3: Classification of Landslides by Area in Plan (Cornforth, 2005)

Description	Area (sq.ft.)	Area (sq.m.)
Very Small	< 2000	**< 200**
Small	2,000 – 20,000	**200 – 2,000**
Medium	20,000 – 200,000	**2,000 – 20,000**
Large	200,000 – 2,000,000	**20,000 – 200,000**
Very Large	2,000,000 – 20,000,000	**200,000 – 2,000,000**
Huge	**> 20,000,000**	**> 2,000,000**

- **Drainage condition**

Table 4: Classification of Landslides by Drainage Condition (Huat et. al., 2008)

Drainage Condition	Description
Drained (long term)	No excess pore pressures are generated during shearing or they are fully dissipated
Partially drained (medium term)	Some excess pore pressures generated during shearing are partially dissipated
Undrained (short term)	Low permeability soils, excess pore pressures are generated during shearing

- **Style**

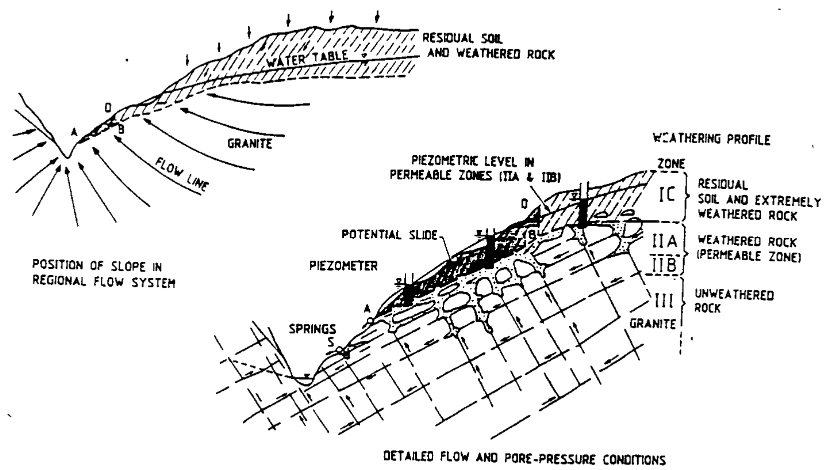
Landslides were classified as shallow or deep-seated because they generally present two distinct types of hazard. Most shallow landslides move downslope rapidly, and can mobilize into far reaching, life-threatening flow-type failures with addition of water at the source, or along the run out path, or when an advancing slide mass encounters a flowing stream. In contrast, deep-seated landslides such as rotational slumps, commonly move at a slower rate and cover a shorter distance. Thus, deep-seated landslides present a hazard primarily to the area on immediately surrounding the slide along the down slope, and some warning, such as the appearance of tension cracks at the crown or bulging at the toe, may precede significant landslide movement (Utah 2006)

Table 5: Classification of Landslides by Shallow or Deep-Seated Failure

Shallow Failure	o Depth to failure plane generally less than 10 feet - 3 m (Utah, 2006) o Depth to failure plane generally less than 4 feet – 1.2 m (Day, R. W., 2004) o Depth to failure surfaces lesser than 10m (Jaboyedoff et. al., 2004)
Deep-Seated Failure	o Depth to failure plane greater than 10 feet - 3 m (Utah 2006) o Depth to failure plane greater than 4 feet – 1.2 m (Day, R. W., 2004) o Depth to failure surfaces greater than 10m and large volume of material flow (i.e. 1,000,000 m^3) (Jaboyedoff et. al., 2004)

- **Geological environment**

Table 6 : Relationship between Geological Environment and Landslide (MacGregor et. al., (1990) and Stapledon (1992))

Granite	

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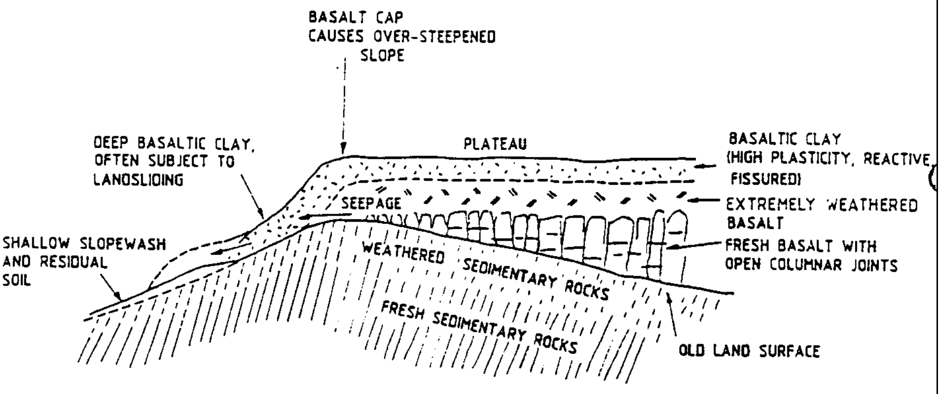
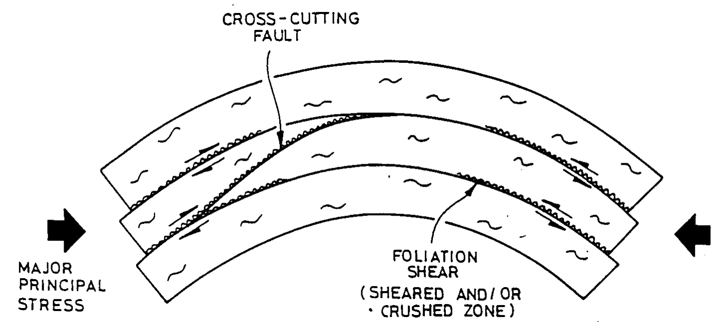
<tr><td>Volcanic</td><td>

Typical profile through margin of basalt plateau, showing conditions which lead to slope instability.</td></tr>
<tr><td rowspan="2">chistose Rocks (eg. schist, slate, phyllite)</td><td>
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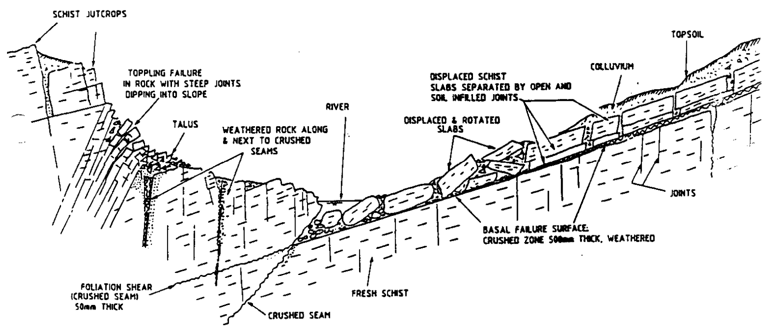
<tr><td>
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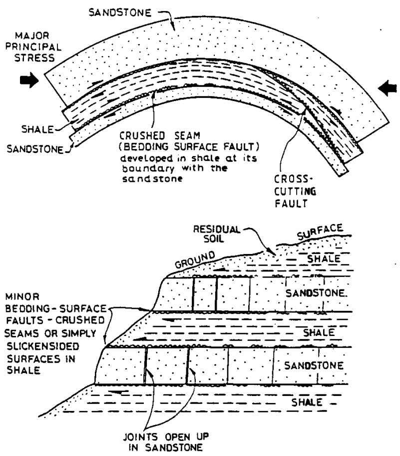
<tr><td>Mudrocks</td><td>
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Siltstones,
Conglomerates</td>
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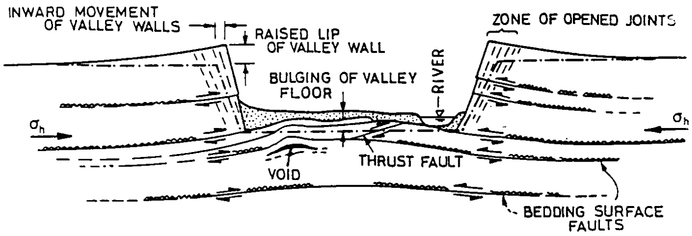

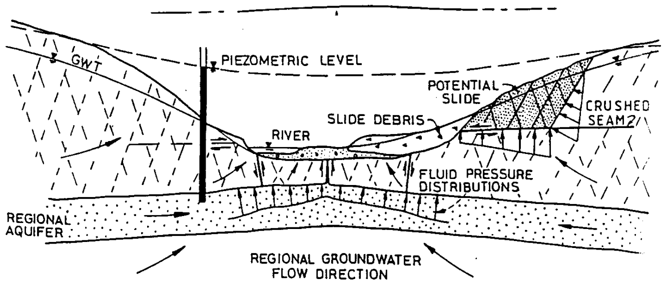

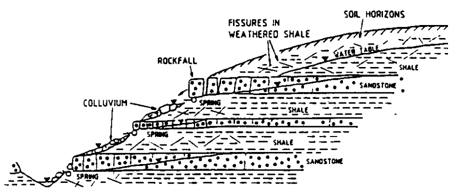

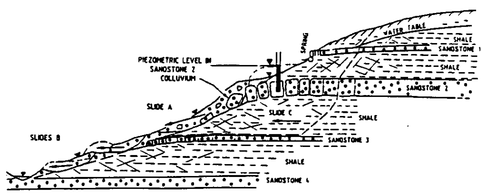
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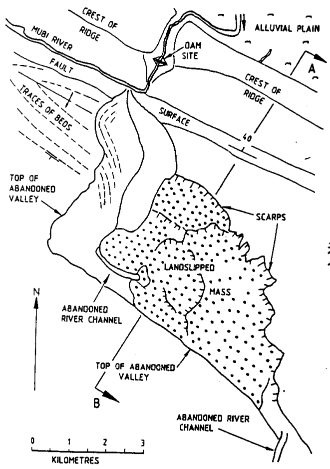

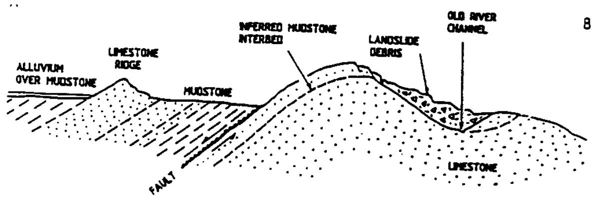

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IV) LANDSLIDE DATABASE IN MALAYSIA (TODATE)

Table7: Series of major landslide occurrences in Malaysia

No.	Date	Location	Type and Nature of Landslide/Slope Failure. Size/Volume	No. of Death	Notes	Main Causes/ Triggering Factors	Policy Impact	Rehabilitation Measures
1	Oct. 1993	Kuala Lipis-Gua Musang	Part of the road collapse due to failure of fill slope following a period of continuous rain	1	-	*	*	*
2	Nov. 1993	Karak Highway	Shallow rotational slide. Failure of cut slope at the side of the highway occurred at dawn - buried in motorcycle rider and its pillion	2	Cut slope in granitic formation	*	*	*
3	Dec. 1993	Ulu Klang, Selangor	Shallow rotational slide. Prolonged and heavy rain triggered retrogressive failure of cut slope behind the Highland Tower apartment - toppled Block A	48	Cut slope in granitic formation	Inadequate design, improper construction, triggered by rainfall	*	*
4	March 1994	Fraser Hill	Collapse of balconies of Fraser's Pine Resort due to landslide	-	Natural slope	*	*	*
5	June 1995	Karak Highway - Genting Highland slip road, Selangor – Pahang border	Debris flow. Failure of upstream natural dam during heavy rain triggered 'snowball effect' debris avalanche	22	Natural slope in meta-sediment formation	Triggered by heavy rainfall	*	*
6	Jan. 1996	Gunung Tempurung , Kampar, Perak	Deep-seated rotational slide. Failure of cut slope (strengthened by anchor and guniting) at the side of North-South Highway	1	Cut slope in granitic formation	Adverse geological, Triggered by rainfall	*	*
7	Aug. 1996	Orang Asli settlement, Post Dipang, Kampar, Perak	Debris flow from erosion and logging activities along upstream of Sungai Dipang occurred during heavy rain	44	Natural slope in granitic formation	Inadequate FOS Triggered by rainfall	*	*
8	Nov. 1998	Bukit Saujana, Paya Terubung, Penang	Massive rockslide	-	Cut slope in granitic formation	Inappropriate design , triggered by rainfall	*	*
9	Jan. 1999	Squatters settlement, Sandakan, Sabah	Shallow rotational slide. Heavy rain triggered landslide - buried a number of houses/huts	13	Natural slope in meta-sediment formation	Inadequate FOS, Triggered by rainfall	*	*

No.	Date	Location	Type and Nature of Landslide/Slope Failure. Size/Volume	No. of Death	Notes	Main Causes/ Triggering Factors	Policy Impact	Rehabilitation Measures
10	May 1999	Bukit Antarabangsa, Ulu Kelang	Massive landslide	-	-	Inadequate design, improper construction, triggered by prolonged rainfall	*	*
11	Jan. 2000	Vegetable farm, Cameron Highlands, Pahang	Debris flow from upstream landslide and erosion washed away workers squatters	6	Vegetable farm on sloping land in meta-sediment formation	*	*	*
12	Jan. 2001	Simunjan, Sarawak	Shallow rotational slide. Landslide occurred on vegetable farm - buried a number of houses at the toe of slope	16	Vegetable farm on sloping land in meta-sediment formation	*	*	*
13	Dec. 2001	Gunung Pulai, Johor	Debris flow. Heavy rain triggered debris flow resulting from a number of small landslides along upstream of Sungai Pulai - washed away settlements along the river bank	5	Natural slope in granitic formation	*	*	*
14	Nov. 2002	Hillview, Ulu Kelang, Selangor	Debris flow. Sliding/flowing of debris soil during heavy rain - toppled a bungalow at the toe of the hill	8	Dumping area of abandoned project in granitic formation	Inadequate design of the adjacent slope, triggered by rainfall, old landslide location	*	*
15	Oct. 2003	Gunung Raya Road, Langkawi	Deep-seated rotational slides. Landslide triggered by heavy and prolonged rain - buried a machine and its operator while clearing the debris.	1	Cut slope in granitic formation	*	*	*
16	Nov. 2003	Bukit Lanjan, North Klang Valley Expressway	Rock Slide/rock debris	-	Cut slope in granitic formation	Adverse geological condition, long term weathering , prolonged rainfall	*	*
17	Nov. 2004	Taman Harmonis, Gombak, Selangor	Debris flow. Sliding/flowing of debris soil from uphill bungalow project - toppled the back-portion of neighboring down slope bungalow after weeklong continuous rain.	1	Dumping area of ongoing project in meta-sediment formation		*	*

No.	Date	Location	Type and Nature of Landslide/Slope Failure. Size/Volume	No. of Death	Notes	Main Causes/ Triggering Factors	Policy Impact	Rehabilitation Measures
18	Dec. 2004	Bercham, Ipoh, Perak	Rock fall - buried back portion of illegal factory at the foot of limestone hill.	2	Natural limestone cliff in karsts formation	*	*	*
19	May 2006	Ulu Klang, Selangor	Landslide due to collapse of retaining wall and retrogressive slope failures. Buried 3 blocks of longhouses.	4	Cut slope in granitic residual soil. The area is also known to be highly susceptible to severe erosion	*	*	*
20	Oct. 2006	Wangsa Maju	Landslide to near the residential Flat Block B4 and Block B5.		Cut slope in granitic residual soil. The area is also known to be highly susceptible to severe erosion	Triggered by heavy rainfall	*	*
21	Oct. 2006	Jalan Sepanggar, Sabah	15 houses were crushed by mudslide*	1	The monsoon rains had loosened soil on hillsides*	Triggered by heavy rainfall *	*	*
22	March 2007	Presinct 9, Putrajaya	Landslide occurred on height hill slope at Taman Rimba Desa, which is also behind the phase 11 Apartments in Precinct 9, Putrajaya.	*	Cut Slopes in meta-sediment formation	Triggered by heavy rainfall	*	*

**Note :* - Still searching for information*

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9. EMERGENCY PREPARDNESS RESPONSE AND RECOVERY

9. EMERGENCY PREPAREDNESS RESPONSE AND RECOVERY

9.1 Overview

9.1.1 Introduction

Despite the preventive measures that could be taken, landslides still happen and sometimes without warning. The National Slope Master Plan (NSMP) rightly calls for a nationwide structured action plan to deal with landslides using a systematic approach. The approach will enable authorities to mitigate landslides through proactive means, and when landslides do happen, deploy an effective response and recovery plan to contain the damage.

The Emergency Preparedness, Response and Recovery (EPRR) component shall propose preparedness, response and recovery measures for landslide ; specifically focusing the equipment, expertise and guidelines required to establish an effective national framework for landslide emergencies. In order to gauge the current status of EPRR in Malaysia, questionnaires were distributed to the agencies and organisations at the federal, state and local levels; interviews were conducted and visits made locally and abroad. The overseas visits were made to compare the different approaches to emergency management and to study their best practices.

The main EPRR aim is to focus on any landslide incident where there is a danger to lives and property which calls for immediate action that exceeds the capacity of normal resources and organisations to cope. Such situations which are the focus of the EPRR management can either be disastrous or non-disastrous but they are always events with potential loss of lives or damages to properties.

This report on EPRR introduces several key concepts and they are defined as follows :

Landslide Emergency

An emergency is an exceptional situation calling for immediate action that exceeds the capacity of normal resources and organisations to cope. In the context of the landslide emergency it refers to an unexpected and an especially dangerous happening where a slope failure is causing danger to lives and property. An emergency can be small and localized or one broad in nature, but it always a dangerous event with potential for loss of lives.

Landslide Disaster

An incident that occurs in a sudden manner, is complex in nature, resulting in the loss of lives, damage to property or the environment as well as affecting the daily activities of the local community. Such an incident requires the rapid marshalling and handling of resources, equipment, and extensive manpower from various agencies with effective coordination amidst the possibility of a demanding complex action requirement over a long period of time.

This definition of disaster is directly extracted from the National Security Council Directive No. 20 or MKN 20 document.

Landslide Incident

A landslide incident is defined as a recorded event of a landslide by the emergency management office of the Slope Engineering Agency ((SEA)). Such an incident can be big (as in a disaster) or it can be small (involving no loss in lives and little damage to property); it can be an emergency-type event or not. As such an incident is an event that can initiate either a call for assistance and relief or none at all.

By having a proper definition of landslide, any inconsistencies in the tabulation of landslides can be eliminated .

Mitigation

Mitigation is acting before a disaster strikes to prevent he occurrence of a disaster or to reduce the effects of the disaster when it occurs. carried out after a disaster to reduce the risk of a reoccurrence

Mitigation includes efforts to prevent man-made or natural disasters by the assessment of threats to a community. These assessments, when translated into action, will reduce the likelihood of a disaster taking place and form an important part of mitigation activity.

Preparedness

Preparedness is being ready to handle a landslide incident and to manage its consequences through measures taken prior to the landslide incident. Preparedness includes the planning, resource allocation, and training of emergency responders and other stakeholder. It also includes disaster response exercises that help people practice what to do if a disaster occurs.

Response

Response is the action taken immediately after a landslide incident to manage the incident that threatens public safety. It includes search and rescue operations, incident management and coordination, evacuation, damage assessment, handling of fatalities and public donations.

Recovery

Recovery is the action taken to restore conditions to an acceptable level or to a condition similar to before the landslide occurred. Recovery involves site wearing the reinstitution of public services, the rebuilding of public infrastructure, and other activities all that is necessary to help restore civic life,including disaster assistance and crisis counseling.

Hazard

Hazard is a condition, an event or a circumstance that could lead to or contribute to an unplanned or an undesirable event. In landslide situations, hazards pose the likelihood of potential losses that can be reduced by improving the understanding of the causes of slope failures and suggesting mitigation strategies.

9.1.2 Objectives

The main intent of this study on EPRR is to ensure that landslides are addressed is dealt with in a coherent and systematic manner whereby emergency response is swift and appropriate to the scope of the landslide incident. It is envisaged that such an approach will minimise the destructive effects of landslides when they do happen. At the same time the approach calls for the adoption of proactive measures to be undertaken to prevent landslides or limit their damaging effects. This approach will be based on the best practices of emergency responses and preparedness measure from around the world.

9.2 Problem Statement

Before we review the current situation, we will briefly look at the history of landslides in Malaysia.

The first landslide tragedy, after the country gained independence in 1957, occurred at Ringlet, Cameron Highlands. On 11 May 1961, at approximately 4pm, a few thousand tonnes of soil buried a row of shop lots (**Figure 9.1**). About 700 people and two bulldozers came to assist and about 30 people were rescued. A woman was rescued after two hours while a 7- year old child was rescued almost four hours after the landslide occurred. In spite of the rescue efforts, the tragedy claimed 16 lives.

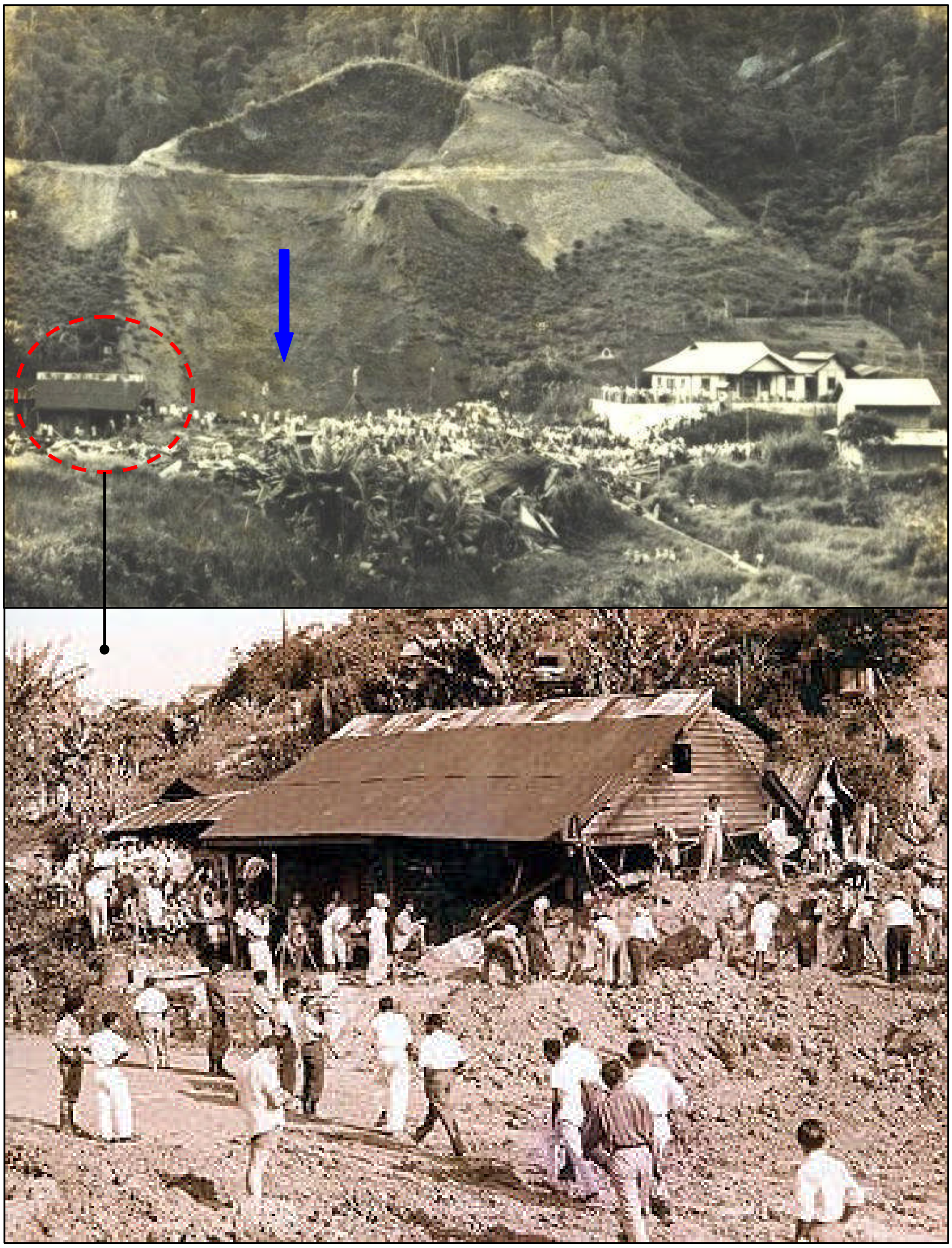


Figure 9.1: Ringlet landslide tragedy, 1961

Between 1961 and 1973, there were no reported landslides in the local newspapers. However, this does not mean that there were no landslides at all. Most likely the landslides that occurred during this time did not claim any lives or cause major damage.

From 1973 onwards there were many landslides being reported in the local newspapers. **Figure 9.2** shows the reported landslides and fatalities from 1973 until 2007.

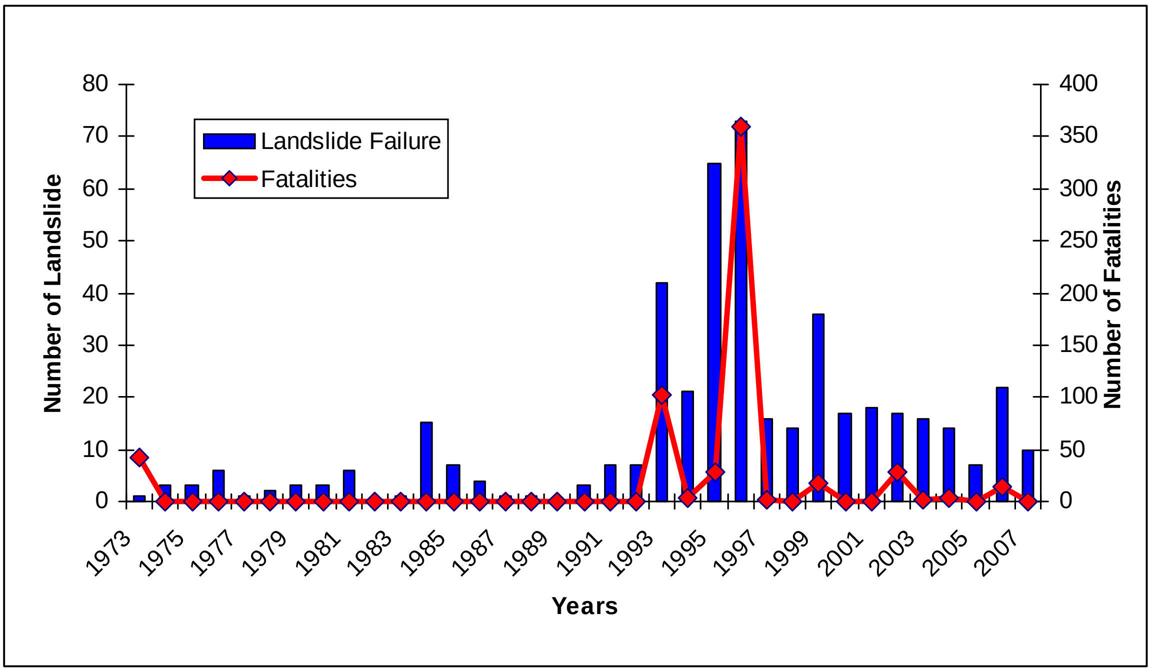


Figure 9.2: Reported landslides and fatalities (1973-2007)

The graph in **Figure 9.2** shows that there was an increase in the number of fatalities with an increase of landslides reported. The highest fatality recorded was on 26 December 1996 where a mudflow caused by the Tropical Storm Greg wiped out a few villages in Keningau, Sabah and claimed 302 lives (**Figure 9.3**).

Figure 9.3: Mudflow which claimed 302 lives in Keningau, Sabah

Out of the 461 landslides reported, 6.5percent involved fatalities. This translates to about a fatality per year. In addition to fatalities, it was also discovered that major landslides, which on an average occurred four times a year for the past ten years, involved consequences of considerable social - economic costs such as :

- Temporary or permanent evacuation,
- Road or highway closure,
- Damage to properties, such as houses and vehicles.

Following the tragedy of the collapse of Highland Towers Condominium, the Cabinet in its meeting on 18th May 1994, made a decision, amongst others, to:

- Form the Special Malaysia Disaster Assistance and Rescue Team (SMART).
- Form a mechanism under the National Security Division (NSD) for the management of disasters on land.

Directive NSD 19 on the establishment of SMART was issued on 2 August 1996 and the Directive NSD 20, or now better known as MKN 20 was issued on 11 May 1997, after there fatal landslides occurred in 1996 which in total claimed almost 400 lives. These two directives issued as a direct response to the major landslide events, were designed to cover disaster management for the entire country as well.

It was only on 2 February 2004, that the Slope Engineering Branch (CKC) was formed under the Public Works Department (JKR). This move was due to the 26 October 2003 rockfall at Bukit Lanjan which caused six months of highway closure and massive traffic jams in Kuala Lumpur and very considerable economic losses. There is no official figure on these losses because there is no single agency tasked with tabulating and calculating these losses.

9.2.1 Current Situation

The current landslide situation is as follows :

- There is no specific legislation to handle landslide disasters and landslides are handled within the general current legislation that is designed to cope with disasters in general. At present, Malaysia has MKN 20 which provides the policy and mechanism to handle disasters of various types on land.
- The country does not have a specific mechanism to handle landslide disasters or emergencies even though MKN 20 was established. Despite some major landside incidents in the last decade, lessons learned have not been distilled nor absorbed into a useful plan to prevent and reduce such incidents.
- The current MKN 20 focuses on relief measures, i.e., response and recovery phases, and little on proactive measures to prevent landslide incidents or disasters such as the preparedness phase. MKN 20 only covers disastrous events, while emergencies that are not defined as disastrous are not covered under this directive.
- Inadequacy of drill exercises amongst the emergency agencies.
- The emergency response agencies requires more up-to-date equipment in their search and rescue missions.
- The lack of data for compiling loss estimates in the landslide disasters that has happen in the past. Such data is necessary in arriving at what outlay, both financial and manpower, should be sensibly spend on the management of landslides.
- The lack of trained geotechnical engineers to provide the emergency response agencies with timely professional advice on the safety of slopes and structures during a slope failure.

- Currently, there is no central agency being recognised to handle landslide emergencies or disasters. Even after the establishment of CKC, local authorities still continue to call upon JMG or IKRAM for advice or assistance.
- Legislations or bodies such as SMART or CKC were formed in the aftermath of successive landslide disasters. But no all encompassing study was made to come up with a comprehensive approach to address and handle landslides.

The current scenario highlights some of the problems that the country's emergency management system faces and must be addressed in order to bring it up to the level of countries whose systems are more matured, efficient and integrated. The findings pointout the inadequacy of drill exercises amongst the emergency agencies. This leads to lack of coordination and integration among them and other stakeholders during an emergency or disaster. Hence, a SWOT analysis is done to help pinpoint the strengths, weaknesses and the avenues to pursue for improving the emergency management system.

9.2.2 SWOT Analysis

A SWOT analysis enables a proper assessment of the current strengths, and weaknesses to help identify the threats and the opportunities to overcome them.

Table 9.1 : SWOT analysis

SWOT	Description
Strengths	Adequate Mechanisms: the present mechanisms and the policies that guide the operations of general disaster management in the country under the various legislations such as the National Security Directive No. 20 and No. 19 (commonly referred to as MKN 20 and 19) are adequate. What is needed is an integrative approach to guide for management of landslide that encompassing not only response but giving equal weight to proactive measures. Basic Emergency Response Agencies Structure in Place: the country has in place the normal emergency response

SWOT	Description
	agencies such as the fire rescue services, the police, the medical services and even a special disaster rescue team known as SMART.
Weaknesses	<u>No inter-agency drill</u>: there is no systematic schedule inter-agency drilling exercises between the various emergency response agencies and other stakeholders even though the various agencies would like this to be effected. <u>No specific mechanism</u>: at present the nation has no specific mechanism to handle landslide disasters or emergencies. Morever, there is no single authority that collects landslide data, determines what constitutes landslide, provides geotechnical landslide experts in a timely manner to help emergency response agencies in a landslide disaster; and no loss assessment. This impedes greatly the development of proactive measures.
Opportunities	The NSMP study a dedicated one-stop agency with clear authority to handle all aspects of slope management, and to overcome all the weaknesses in the present setup. The NSMP calls for a nationwide structured action plan to deal with landslides using a systematic approach. The approach calls for effective implementation of the four phases of emergency management which are mitigation, preparedness, response and recovery. This approach will enable the authorities to manage landslides through proactive means, and when landslides do happen, give a quick and effective response and recovery measures to limit the damages.
Threats	If no clear measures are taken to address the weaknesses in the current systems the present situation to continue. actual response to landslide incidents will continue to be addressed on ad hoc approach and the outcome of the landslide management will depend on luck and circumstances. With continued hillside development, there will be more

SWOT	Description
Threats	man-made slopes. This increases the probability of more landslide incidents. Ambiguities in management and implementation of landslide response and recovery measures have and will continue to contribute to assigning blame and lack of accountability by responsible parties.

9.2.3 Needs and Constraints

- **Needs**

First and foremost, there is a need to set up a dedicated agency that is able to handle slope failures when they occur as well as having the technical expertise to provide assistance in all aspects of slope engineering and slope management. This agency must equip stakeholders with the capability to prevent landslides through proactive means, and when landslides do happen, give a quick and effective response and recovery measures to limit its damaging effects.

The agency must be able to learn from landslide incidents, distill these lessons into its policies and practices and use them to prevent future occurrences. It must be able to thoroughly collect landslide data, maintain a comprehensive database of landslides, provide geotechnical landslide expertise to government bodies and organisations, provide forensic investigation reports and conduct loss assessment studies.

The agency must be adept in managing data and information. Data must be gathered for budgeting both financial and manpower outlays. Conversely must disseminate information and expertise in geotechnical engineering and aid to help respond appropriately in landslide incidents. As such, the training and retaining of trained geotechnical personnel for emergency services is crucial.

For emergency response agencies involved in landslides, the following is required:

- Equipping the emergency response agencies with more up-to-date equipment in their search and rescue missions.
- Conducting regular drill exercises amongst the emergency agencies to improve coordination and integration among them during an emergency or disaster.

- **Constrains**
  - The paucity of landslide data, the lack of consolidated data, the difficulty in locating basic data, the non availability of loss assessment data is a huge constrain in landslide management studies. Much time is wasted in data acquisition; and its lack especially of loss assessment data actually impedes the ability of policy makers in providing adequate funding for landslide management.
  - The lack of inter-agency real life drilling scenarios is another constrain in the provision of better emergency response in landslide incidents as well as in other types of disasters. The various emergency response stakeholders all see the need for mandated mutual co-operation periodic integrated simulation exercise, wish for it but have not tasted the benefits of inter–agency drills. This constrain needs a higher authority to co-ordinate to overcome single agency inertia as all individual response agencies seems not to be want to be seen subservient to another.
  - The lack of trained geotechnical engineers in slope management to provide the emergency response agencies with timely professional advice on the safety of slopes and structures during a slope failure. Training and the keeping of trained geotechnical personnel in the service would be the answer.
  - Currently there is no central agency being recognized to deal with landslide emergencies or disasters. Even after the establishment of CKC, it is still a norm for local authorities to call upon JMG or IKRAM for advice or assistance. A dedicated agency with authority and the expertise will help.

9.3 Detailed Study

9.3.1 Introduction

The NSMP study formulates for a nationwide structured action plan that identities measures to handle landslides in a systematic manner. Towards this end detailed studies and observation visits were conducted at agencies.. The study findings were used to formulate a framework of strategies and action plans that will enable the authorities to mitigate landslides, and when landslides do, deploy a quick effective response and recovery plan to contain the damage.

The frameworl for EPR will review and improve preparedness, response and recovery measures for landslide disaster management, explore means provide the various emergency response stakeholders with geotechnical support during emergencies, augment the knowledge and skillsets of the various local authorities in slope management and generate loss assessment data and other pertinent landslide data for use by the government and the public.

9.3.2 Literature Review

A review was carried out on the main legislation that defines the roles, the and the authority by which disasters and emergencies are managed in the country. These are:

- National Security Council Directive No. 20 (MKN 20)
- Police Act, 1967
- Fire Service Act, 1988
- National Security Council Directive No. 19 (MKN 19)

Review of Directive No. 20, National Security Council

This directive titled 'The Policy and Mechanism on National Disaster and Relief Management' describes the policies and mechanisms to be implemented during disasters (see **Figure 9.4**). The objective of this directive is to establish a disaster management and relief system that will provide a swift, coordinated and effective response to any disaster.

This directive defines disaster as "a sudden and complex incident which causes loss of lives, damage to property or natural environment, severely affects local activities and requires effective coordination of many related agencies". Landslide is classified as one of the possible disastrous incidents in this directive.

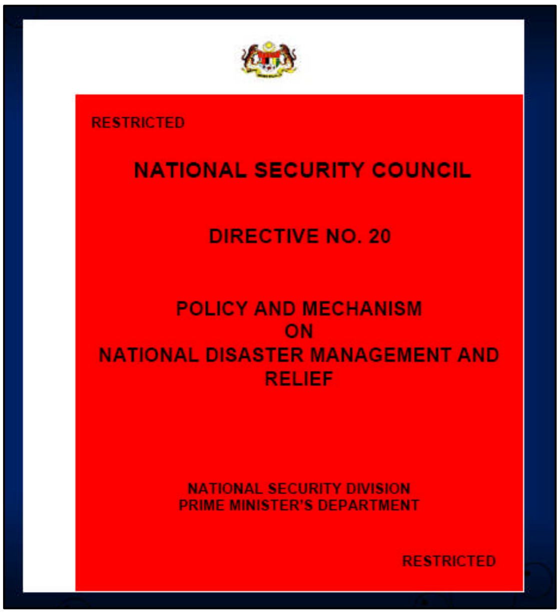


Figure 9.4: National Security Council Directive 20 (MKN 20)

Disaster management under this directive is divided into three levels: level I, level II and level III. Implementation of procedures under these levels is based on the complexity of the disaster, the number of victims and the impact it has on the affected communities and the public at large.

The levels of disaster with its respective committee in charge, explained in **Table 9.2**.

Table 9.2: Levels of Disaster according to MKN 20

Level I Disaster	Localized, not complex, controlled by district authority. Lead by **D**istrict **D**isaster **M**anagement and **R**elief **C**ommittee (DDMRC)
Level II Disaster	Covers more than two districts, potential to spreading, complex in rescue efforts. Handled by state authority. Lead by **S**tate **D**isaster **M**anagement and **R**elief **C**ommittee (SDMRC)
Level III Disaster	Covers more than two states, handled by authority at central level. Lead by **C**entral **D**isaster **M**anagement and **R**elief **C**ommittee (CDMRC)

Of the three levels, the Central Disaster Management and Relief Committee is the highest authority in managing disasters and is charged with the following responsibilities:

- Formulate policy and draft strategies on national disaster management
- Educate communities in the aspects of prevention and preparation
- Ensure that the agencies are given management development and training
- Ensure that the directive is applied at all levels in disaster management

In addition to the above, a related authority in disaster management is the National Security Council. The role of the National Security Council includes:

- Acting as secretariat for DMRC
- Ensureing post mortem is done
- Charging with issuing orders to SMART to mobilise operation team
- Providing financial allocation at the initial stage

Corresponding flowchart outlining the process of defining an emergency to assign it to the appropriate committees is given in **Figure 9.5**.

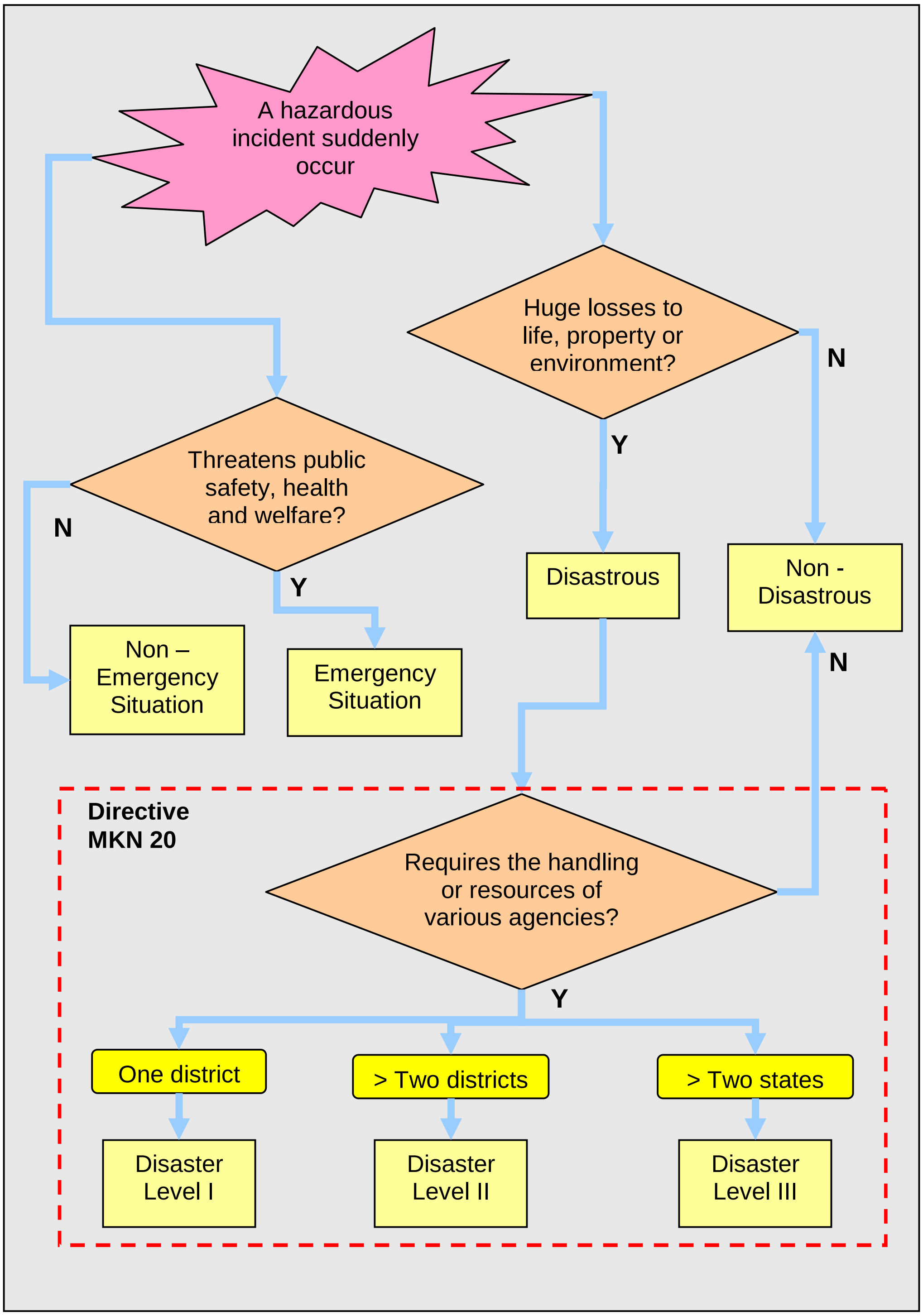


Figure 9.5: Categorising emergency and disaster

Review on Police Act 1967

The Police Act 1967, is more focuses crowd control and public safety. During a landslide emergency, the police as the Incident Commander can apply Section 21 titled 'General Roles of Police Officer'. This section states the responsibilities of a police officer as:

- Aligning, controlling and diverting traffic flow
- Controlling and ensuring safety in any of area of public access including public roads, alleys, shortcut roads, landing area, public access area, and public visit area
- Preventing interruption during gatherings and parades on public roads and alleys, within any context, when any road, alley, short cut road and landing area or ferry that is crowded or being interrupted
- Giving the police the authority to arrest and fine anyone who interrupts or protests or denies any reasonable order during a landslide emergency.

Review on Fire Services Act 1988

The Fire Services Act defines responsibilities and the power vested upon the Fire Officer in firefighting activities. Section 19 in the Act covers activities that do not involve fire and is applicable for landslide emergency situations. This section titled 'Power of Fire Officers in Emergencies Which Do Not Involve Fire' states that on the occasion of an emergency that does not involve fire or the risk of fire, the powers referred to in section 18 shall be exercised by any fire officer if he is of the opinion that lives or property are in imminent danger. In relation to a landslide emergency, the Fire Service Act can be applied to handle search and rescue operations for landslide victims. The actions are as follows:

- Taking such measure as deemed necessary or expedient for the protection of life and property
- Removing any person interfering by his presence or actions with the operations of the Fire Service Department
- Entering, breaking into or through, and taking possession of or demolished, any premises, place, or thing for the purpose of putting an end to the fire, or protecting the premises compound, or thing from the fire, or for rescuing any person or thing.
- Closing any street near the site of the fire, and control the traffic or crowd in any such street
- Using any convenient supply of water

<u>Review on Directive No. 19, National Security Council</u>

The directive is titled 'Special Malaysia Disaster Assistance and Rescue Team (SMART)'. The purpose of Directive 19 is to highlight the procedures and role of SMART in search and rescue operations during a disaster. SMART is an elite team that consists of selected skilled personnel from the Army, the Police, and the Fire and Rescue Department. The role of SMART is listed as below:

- Specifically to search and rescue victims during a disaster.
- Assist existing rescue agencies when their skill, expertise and equipment are required

SMART is attached under the Directorate of Crisis and Disaster in the National Security Division. The response time is divided into two categories, which are:

- In the occurrence of disaster within the Klang Valley area, the team must reach the location within two hours after they have been informed. For the occurrence of disaster not within the Klang valley area, the response time depends on the travel distance of the disaster area to the SMART base.
- In the occurrence of disaster abroad; the team should reach the location within 24 hours after instruction from the Prime Minister.

9.3.3 Feedback - Questionnaire Survey

To gauge the level of the degree of preparedness in landslide disasters and emergencies on the part of federal and state agencies, a questionnaire was forwarded to 16 agencies. The questionnaire touched on seven key indicators:

- Emergency management plans
- Drills on disaster
- Standard Operating Procedures (SOPs)
- Response to landslide disaster
- Availability of expertise for landslide
- Availability of equipment for landslide
- Recovery post-mortem report

The questionnaire responses showed that only a few public emergency response agencies actually have the organisational capabilities and the equipment to handle landslide emergencies, which are Civil Defence and the Fire Department. The other departments provide only support services. The survey provides a broad picture of the current status and highlights what needs be done. **Figure 9.6** summarises the results of the questionnaire responses.

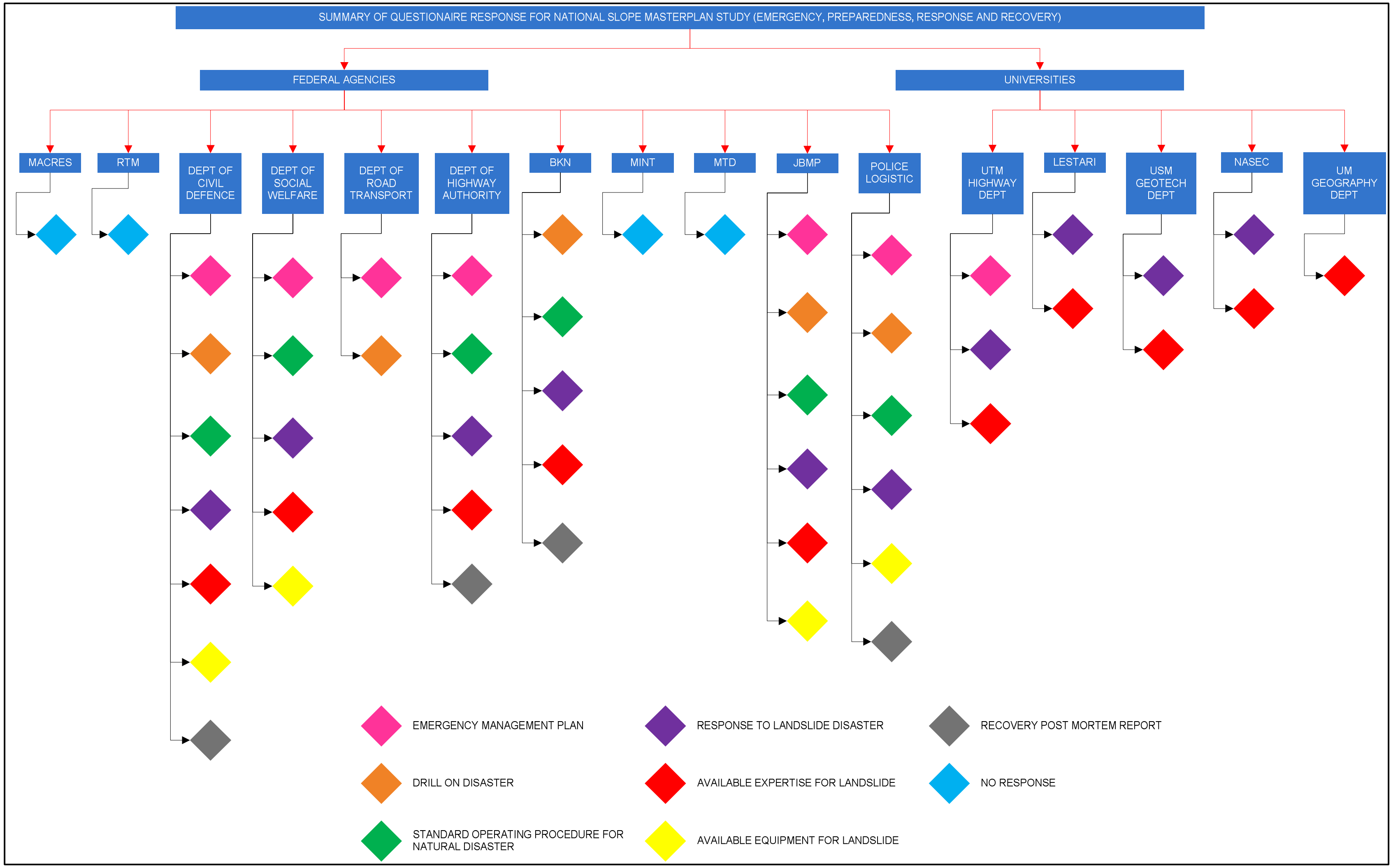


Figure 9.6: Summary of questionnaire response for emergency preparedness, response and recovery

9.3.4 Feedback - Main Emergency Stakeholders

This section feedback gathered from interviews, meetings and discussions with stakeholders involved in relief efforts during landslide emergencies or disasters.

<u>National Security Division (MKN)</u>

An interview and a meeting were held with MKN (**Figure 9.7**), the division responsible for disaster management in Malaysia. Some of the points highlighted by MKN are as follow:

- MKN would support the formation of a central agency to manage slopes and assist in landslide emergencies and disasters.
- MKN is of the opinion that the master plan should only focus on the actions and costs required by the new central agency, not on the actions that is performed by and currently implemented by other agencies involved in disasters or emergencies.
- MKN is currently revising MKN 20 and preparing a few more standard operating procedures (SOPs) for implementation for various disasters. An SOP for landslide disaster is needed.

Figure 9.7: Meeting with the National Security Division (MKN)

Fire and Rescue Department (Bomba)

Bomba's main role in a landslide disaster is to conduct search and rescue (SAR) operations. In any SAR operation, Bomba will make sure that rescuers from all supporting agencies are safe and they have the right to stop any that fails to meet the minimum criteria of safety. Further findings from the discussions are:

- As Bomba is the lead agency for SAR, they already have a wide range of high tech SAR equipments. At the time of the interview, Bomba was planning to buy a new automatic search trace the location of victims who are still alive by detecting their heart beats. However, no decisions was made as of yet, as they are still evaluating the effectiveness of this device since it is very expensive.
- Other equipment deployed in a landslide SAR operation are excavators. To Bomba, an excavator is critical as it can move heavy loads not possible to do manually within the timeframe required. These machines are normally rented or commandeered with payment made promptly. It would be prudent to purchase a suitable size excavator for landslide SAR operations.
- Bomba also has a canine unit for SAR operations. They are useful for SAR in landslide incidents.
- Bomba have basic medical equipment for treating injuries involving bleeding, broken bones and breathing difficulties. The equipment is just sufficient to provide the victim with emergency medical care sustain them before the victim is fully pulled out from the disaster area.
- Bomba strives to ensure that their personnel work in a safe environment as much as possible. To this end, Bomba utilizes an equipment called the Distress Signal Unit. This equipment is a tracking device that gives a warning signal to alert the nearest follow rescuer if a rescuer encounters any difficulties during a SAR operation. In addition, Bomba utilizes GPS trackers, but this is only for the equipment but not for the rescuer. It will be very useful if more GPS trackers can be made available to Bomba.
- To serve Bomba personnel, Bomba has its own ambulances to rescue their injured officers only; not to cater to other victims during a disaster. Bomba has a fleet of airborne ambulances such as the two units of the Mi-17 helicopter and two units of the Agusta (109E) Helicopter.

- In terms of communication equipment, every emergency agency uses its own communication device. At the time of interview, there was no communication system that can interface with all the various emergency agencies.
- Bomba has its own panel of technical advisors who are currently appointed from government departments. They will only utilize these experts as and when needed.
- Bomba feels that there is not enough integrated drill among the emergency agencies. They feel that this is very necessary requirement.
- Bomba suggests that the Police Department issues a prompt notification to other emergency agencies in the case of emergencies or disasters. This is in order to alert other emergency agencies with firsthand, real-time emergency bulletins so that the emergency agencies can react on time.
- Bomba needs geotechnical engineers to provide timely advice in landslide operations. They are of the opinion that it is best if they could get technical advice on the stability of the slope before and during the SAR operation.
- In landslide incidents that involve the collapse of a structure, it is good to have a structural engineer or the architect of the building present during the SAR operation as they are familiar with building safety and the building conditions. JKR can be such an advisor for landslide incidents.
- Bomba should have more 4-wheel drive vehicles for accessing sites in remote areas or in rough terrain conditions.

Special Malaysian Assistance and Disaster Rescue Team (SMART)

A meeting was held with SMART to follow up on the questionnaires sent to them. Other than the questionnaires, there were salient points that should be highlighted:

- At the time of the interview, SMART has only one office which is at Jalan Semarak, Kuala Lumpur andwhich will be relocated to Putrajaya later.
- SMART's response time is two hours for incidents within the Klang Valley.
- SMART has a specialized SAR equipment suitable for searching victims buried under landslides (Refer to **Figures 9.8 - 9.9** below). Similarly to BOMBA, SMART was in the process of requesting the procurement of a high-tech sound detector which could detect and classify heart beats
- Like Bomba, SMART felt that excavators in particular small excavators, would be very helpful in a landslide SAR operation.

- Based on SMART's experience in landslide SAR operations, the maximum time duration or window to rescue a buried victim is only two hours.

Figure 9.8: SMART's optical and acoustic search equipment owned

Figure 9.9: SMART's optical search equipment with a flexible camera

Civil Defence Department (JPA3)

In a discussion following the questionnaires sent to JPA3, several points were noted:

- JPA3 is affiliated with the local universities to tap their expertise during landslide disasters. Through this affiliation, expert advice could be given to the emergency services agencies, if required.
- In other countries, such as Singapore and Brazil, to the civil defence department leads the overall disaster management throughout the country.
- JPA3 has produced material for public awareness, including one for landslides.

Emergency Medical Services (Government Hospital)

In an interview with Penang Hospital's Accident and Emergency Department, the following points were noted:

- The lack of 4x4 ambulances among the emergency response agencies is acutely felt when landslides occur in terrain that is not passable for ordinary ambulances.
- In Penang there is already one system of communication that is being used between the officer in charge of disaster and the emergency responder.
- A common occurring problem in Penang during a landslide emergency is poor communication as transmissions are prone to interruptions by the undulating and hilly terrain.
- Difficulty to access the disaster area due to indiscriminate parking of cars along the access road.
- Developers should construct alternative roads in their development area.
- Building owners need to make sure that there are no obstacles on the access road at all times.
- All building owners, developers and communities need to set up emergency management plan in their area to prepare for emergencies.
- Geotechnical experts from JKR should be at the disaster site in order to advise the rescue team on slope stability for safely considerations in rescue works. Their presence will boost up the confidence level of the rescue team.

During the Disaster Awareness Seminar 2007, the Ministry of Health (MoH) highlighted that other than providing medical services to injured victims during disaster, MoH also provides:

- Monitoring and control of contagious diseases

- Treatment of non-contagious diseases
- Antenatal and post-natal treatment

Social Welfare Department (JKM)

Two interviews were conducted with JKM, one at the HQ level and another one at the state level in Penang. The following important points were noted:

- JKM's main role is to prepare and manage evacuation centres throughout the country.
- Another important role of JKM is to provide food and shelters for the victims. JKM can provide up to RM5,000.00 for each affected family. The amount is just to help the victims with immediate needs and are not a loss replacement allocation.
- JKM provides relief and recovery support after the disaster. They have (4) permanent counselors and can appoint another ten when needed.
- JKM assists families who have lost their homes by facilitating their requests through other government departments.
- One of their challenges in handling disaster relief is to identify the truly-affected disaster victims as there will be many unaffected who will try to take advantage of the situation. A pilot project was undertaken at Penang to solve this issue by having an updated database of occupants in flood prone areas.

Malaysian Red Crescent (PBSM)

Two interviews were conducted with PBSM, an auxiliary agency under the Ministry of National Unity and Social Development. The second interview and visit was conducted at PBSM's headquaters. Points noted are as follow:

- Other than providing ambulance services, PBSM's main task is to cook at evacuation centres. Their staff is trained and facilities are available to provide for a large number of victims (**Figure 9.10**).
- PBSM also stores large quantities of food, beds, televisions, tents and crucial relief equipment, such as generator sets and water filtration system, in anticipation of disaster (**Figure 9.11**).
- PBSM requires more ambulances for their operations. They normally depend on donations from the private sector.

Figure 9.10: Cooking equipment used at evacuation centres

Figure 9.11: Emergency relief equipment stored in custom built containers

Findings on Emergency Ambulance Services

Currently, the ambulance service providers are the Civil Defence, St. John Ambulance of Malaysia (SJAM), and the Malaysian Red Crescent (PBSM). The government hospitals mainly provide ambulance services to ferry patients from one hospital to another, which is basically a 'non-emergency ambulance transport service'.

The main service provider to dispatch ambulances during an emergency is Civil Defence. If more ambulances are required, the Civil Defence through mutual understanding will contact SJAM or PBSM for their assistance. The ambulance services of SJA and PBSM are mainly run based on donations and funding from the public and private sectors.

The Civil Defence has three types of ambulance raging from Class A, Class B, and Class C. Class A ambulances are the most sophisticated and are assigned to trauma related emergencies. It is equipped with state-of-the-art equipment such as hydraulic absorbers, antilock brake system (ABS), mini surgical operating room, Cardio Pulmonary Resuscitation (CPR), and Automated External Defibrillator (AED) equipments, and has to be accompanied by a Medical Officer, who can perform minor surgeries. At present, the Civil Defence has five units of Class A ambulance.

The St. John Ambulance (of Selangor State) has designated zones such as Coastal, Central and Northern as points for despatching ambulance with its own hotline number. SJA is only active in some states such as Penang and Johor where they provide emergency ambulance services.

The Malaysian Red Crescent Society (PBSM) at Kuala Lumpur (HQ) has a fleet of 19 ambulances covering Kuala Lumpur and parts of Petaling Jaya (see **Figure 9.12**). Each ambulance is accompanied by qualified Ambulance Medical Aid (AMA).

Figure 9.12: Fleet of Ambulance at PBSM (HQ)

The ambulances (mostly Class B and Class C) are equipped with basic life support system and essential equipment such as oxygen cylinder, spinal board, scoop stretcher, cervical collar, first aid kit and air inflated splint and maintains two-way radio communication with the emergency command centre. At present, there is no provision of Class A ambulance by PBSM due to lack of funding.

PBSM is active in some states such as Selangor, Johor, and Penang providing emergency ambulance services. However, the number of ambulances is relatively small as Selangor has six ambulances, Johor has 5 ambulances, and Penang has six. The emergency ambulance service in the state of Penang by PBSM is rather unique as the ambulances specifically cater to the needs of the government hospitals. In Penang, when the public calls '999', the operator will connect them to the nearest hospital, and the hospital concerned will locate the ambulance nearest to the scene of accident. The above scenario is aimed to minimise the response time to the scene of accident. The PBSM (Penang Branch) has its own hotline number for emergency ambulance services.

Effective 1st January 2008, medical emergency calls to request for emergency ambulance services will be diverted to the relevant government hospitals. It is anticipated that the above ruling may encounter some issues as the bulk of the ambulance is still being maintained by Civil Defence (93 ambulances) and other ambulance service providers.

Findings on Emergency Communications

From 1st January 2008 onwards the public needs to only call one emergency service number which is 999 for emergency services. Mobile phone users need to call 112 and the call will be diverted to 999. Prior to this, there were four emergency numbers as listed in **Table 9.3**.

Table 9.3: National Emergency Service Numbers Before 1st January 2007

Emergency Service Number	Remarks
991	Civil Defense Department, Covers major accidents, humanitarian relief and national disaster
994	Hotline for Fire and Rescue Department
995	Gas-related emergencies
999	General emergency calls/police/ambulance

The definition of *emergency services* according to the Malaysian Communications and Multimedia Communication (MMC)' is 'a service which enables a caller to dial a short code whereby the calls to such service is either received by an operator who will connect the caller to the Royal Malaysian Police Force (PDRM), Ambulance or Fire and Rescue (Bomba), or the call is terminated directly at a particular emergency service organisation.'

The national emergency service number is manned by Telekom Malaysia Berhad (TM). Dialling 999 during an emergency will divert the caller to the Telekom operator manning the emergency call centre (TM Call Centre). The Telekom operator has to answer a call within the timeframe of about 10 seconds (fourings). Thereafter, the operator will verifiy the call by asking four standard questions:

1. Name of the caller
2. Details of the emergency

3. Location
4. Contact number of the caller

By verifying the telephone number of the caller, the operator is able to contact the caller in the event the call gets disconnected and able to determine the location of the caller by cross-referencing the telephone number (terrestrial line) against a location database.

- Once the operator gathers the important information, it will take 10 to 30 seconds to call and transfer the information to the relevant emergency service agencies which is PDRM, or Bomba, or the Civil Defense and or the nearest government hospital.
- Once the call is handed over to the relevant emergency service agencies, the response time to act shall be within the timeframe of about 60 to 90 seconds.

Currently, CKC is not identified as the agency to be informed for landslides. It would be prudent to integrate the new slope agency SEA to be informed of any landslide emergency in order to improve response time.

9.3.5 The International Scene

Technical visits were made to Hong Kong and Japan as these two regions have well-developed emergency response management systems in place with state-of-the-art equipment and well-trained personnel.

A review and study was made on the Federal Emergency Management Agency (FEMA) to understand their system. This is due to the widely held and internationally acknowledged view that FEMA is one of the best role models in disaster management in the world.

Federal Emergency Management Agency (FEMA)

FEMA is an agency of the United States Department of Homeland Security. The agency's main purpose is to coordinate the response to a disaster which has occurred and which overwhelms the resources of local and state authorities. FEMA touches on the overall aspect of emergency management by dealing with the four phases of emergency management, i.e., mitigation, preparedness, response and recovery. First, it concerns itself with the role of emergency manager. In FEMA, the emergency manager's roles and functions are stated below:

- Coordinates the plan of various components of the emergency management system
- Acts as a stage manager as well as producer and director, all roles in one.
- Ensure a well-executed performance
- Understands his relationship to the rest of the cast
- Helps to manage the application of resources that other managers control. Also helps managers apply their resources wisely and in a coordinated way
- Works closely with all the emergency response managers
- Works closely with emergency agencies and is part of a national emergency management system that is capable of responding to emergencies with a national impact.

It was noted that in many jurisdictions, emergency is often defined as an incident that threatens public safety, health and welfare, and most have procedures which ensure that local firefighters or law enforcers will be the leading officials in managing the emergency. This is similar to Malaysia's approach.

Japan Technical Visit

As part of the plan to gather pertinent information to formulate a system of slope management that is suitable to the nation, a technical study visit was made to Japan in September 2006. Japan has a rugged terrain subject to annual battering in turn by typhoons with intense rainfall and snowstorms with heavy snowfall. This in concert with frequent earthquakes, has forced Japan to develop a sophisticated landslide management system to handle landslide disasters and put into place preventive measures that form the mitigation and preparation phases of the emergency management cycle. The information gathered through briefings at the various locations is outlined below.

Handling of Landslides along Roads

Japan's approach to handling landslide incidents along its roads is very proactive; an emphasis is given to early warning and loss reduction measures. A list of the slope counter-measures in overcoming road landslides is listed below:

- Shotcreting to prevent slope weathering
- Rock-sheds protect road from rockfall
- Combination of counter-measures against fragile geology – rock sheds, fencing and netting to protect from rock fall
- Sensors installed on fragile slopes provide early warnings of any instability. Rainfall monitoring is often part of an early warning system. Wire sensors to detect mud flows and on-line cameras can form part of the early warning system
- Breakwater facilities are installed against wave erosion to protect road embankment along coastal roads
- Road inspections on dangerous slopes adjacent to roads are carried out to prevent an occurrence of a disaster. Sections that are highly dangerous and hazardous are selected in advance, and a qualified slope inspector performs reconnaissance to verify its safety
- Because of its heavy rainfall and the possibility of landslides on steep slopes, Japan monitors precipitation from the start of a rainfall and will close roads as and when necessary.
- Japan has a system called Traffic Management System for Cut Slope whereby they can display real-time stability of a given slope: this can be coupled to an early warning system to prevent a landslide disaster. Data on ground water content on the targeted slope is linked to forecasted data on short term rainfall. Using an artificial neural network analysis for ranking of high-risk cut slope the data, is collated, and statistically analysed to compute risks on possible slope instability.

The emphasis given to landslide disaster prevention through such slope counter-measures is seen in Japan's budget on disaster prevention: it has ballooned some 440 percent from years 1976 to 2000. In Gross Domestic Product (GDP) terms, the country allocates some 8 percent of its GDP to road disaster management. This type of financial outlay has brought a 530 percent reduction in road disasters (**Table 9.4**).

Table 9.4: Year (in 5-year period) against investment and number of road disasters

Year	Investment in Disaster Prevention	No. of Road Disasters
1976-1980	0.5 Trillion Yen (RM15 billion)	160,000
1981-1985	0.7 Trillion Yen	140,000
1986-1990	1.2 Trillion Yen	90,000
1991-1995	1.6 Trillion Yen	60,000
1996-2000	2.2 Trillion Yen	30,000

Emergency Control Centre

During the visit to the Kanto Regional MLIT headquarters, the technical study team had an opportunity to visit its Regional Disaster Centre. This emergency disaster centre is activated when a disaster happens in the Kanto region. At this centre all monitored data and captured images from sensors and cameras in the Kanto region is presented on a large screen. This centre caters for all types of disasters, from landslides, typhoon, and earthquakes to tsunamis and snow avalanches.

As stated, this disaster centre is activated only when a disaster happens. The disaster management organisation does not physically exist all the time; when there is no disaster, the organisation only exists in virtual mode. It becomes physical only when a disaster has occurred.

The centre has an impressive set of equipment. It can store captured data and photos, has analysis capability and can display all these on display panels. The cameras on site can capture images under streetlight conditions and has zoom-in capability.

Equipment Storage and Supply

During the visit to the MLIT Funabashi Disaster Response and Recovery Centre, the technical team could see the storage of essential equipment and materials to be used in a disaster. Equipment is also stored at various storage centres throughout the Kanto region to meet the emergency needs of the specific area.

The most notable facility an emergency mobile site office that can accommodates between 20 to 50 personnel and is fully equipped with communications equipment, a mobile adjustable tower lamp able to illuminate a distance of more than 50 meters, cranes, Bailey bridges, tripods for construction of embankments of 3 to 4 tonnes (**Figures 9.13 – 9.14**). The centre also has a system set up for dispatching their equipment and emergency teams within 60 minutes of notification.

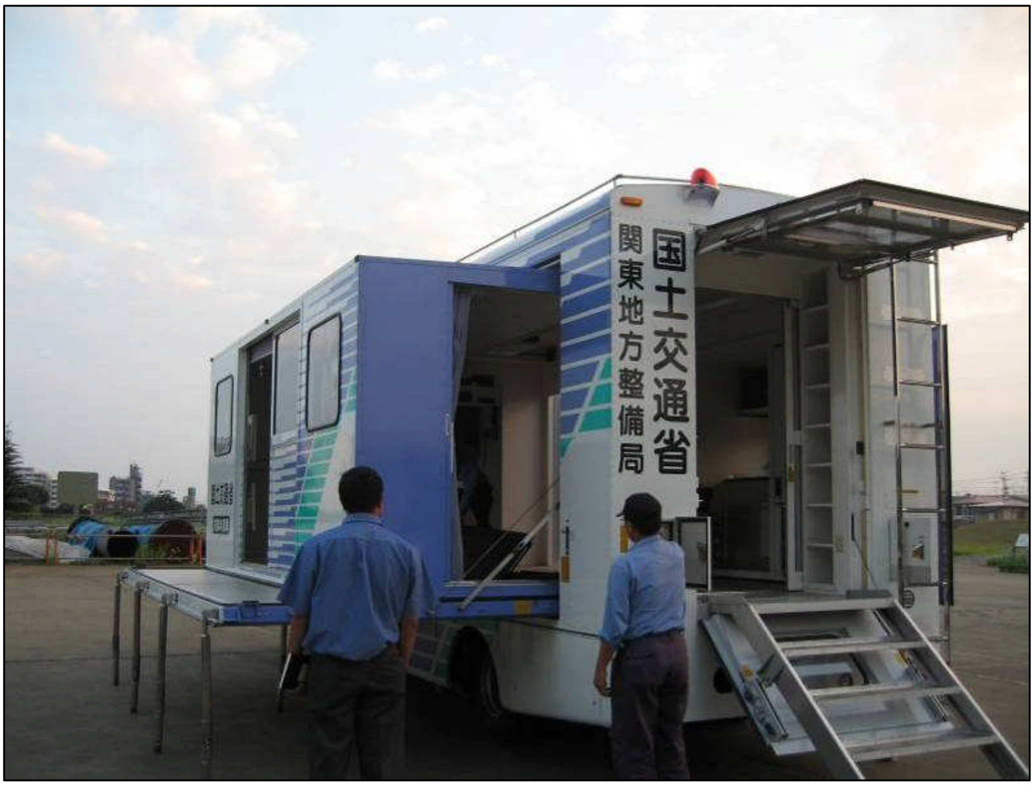


Figure 9.13: Mobile emergency control office (20-50 people)

Figure 9.14: Mobile adjustable tower lamp and the site office

Visits to International Consortium of Landslides and Landslide Research Institute

These visits provided useful information on the future direction of research in the field of landslide control and management. The objective of the International Consortium of Landslide (ICL) headquarters is to integrate geosciences and technology in order to better evaluate landslide risks as well as to combine and coordinate landslide risk assessment with mitigation studies at an international level.

The consortium has furthered its international cooperation aims by adopting an action plan designated as the Tokyo Action Plan where the emphasis will be on the preparation, mitigation and recovery phases of the emergency cycle. For instance, for the mitigation phase, they will concentrate on strengthening the state of preparedness of both the public and the local stakeholders in the emergency management of disasters. This will involve putting in place systems that can provide forecasted early warning of slope instability to stakeholders as well as design contingency recovery plans to handle such slope instability should it come to pass. Ecologically sound landslide mitigation techniques such as appropriate land use zoning with controlled development is emphasised.

The action plan for the recovery phase of a landslide disaster is to conduct a post landslide study to determine what happened and apply the lessons learned into the area of landslide mitigation and prevention. Such studies will include the active participation of the affected local residents. Re-building efforts will include studying the psychological aspects of health and social issues as they affect the local community; this means that a long-term support program approach is considered necessary and should be adopted.

Usefulness of Japan Technical Visit

From what was gathered during this technical study trip to Japan, it can be said that the team observed many useful practices that maybe applied here. The Japanese use of technology in sensing and monitoring of rainfall, ground movements and mud flow detection, together with a unified communications system, can provide a useful platform for Malaysia to build upon. Information gathered during the visit showed that the Japanese over the years exhaustively gathered all useful data to arrive at threshold levels enabling them to model an early warning system that suited their circumstances. Their continual investment in research and development will enabled them to make incremental improvements in disaster management in areas of prevention.

Hong Kong Technical Visit

The Hong Kong Setup

The Geotechnical Engineering Office (GEO) in the Civil Engineering Department (CEDD) in Hong Kong has a plan to handle disasters known as the Contingency Plan for Natural Disasters, and it lays out the functions and responsibilities of the various governmental departments and other stakeholders such as volunteer organisations in the event of a natural disaster.

- GEO-CEDD has an organisational structure that is delineated according to authority levels, with three levels equivalent to Malaysia's district, state and federal levels, with the highest level being the office of the Chief Executive. GEO determines the level of an emergency. It categories emergencies according to three categories:
    - Serious – involves casualty, major evacuation, or serious traffic disruption
    - Significant – significant disruption to the community

   o   Minor – no immediate consequence

- There is a distinct lack of coordination issues between incident handlers during a disaster. The smooth coordination is partly due to their having all their main government departments that are activated in a natural disaster such as Fire Brigade, Police, Civil Aid and Auxiliary Medical being under one bureau, the Security Bureau, which is akin to Malaysia's Ministry of Home Affairs. This is shown in **Figure 9.15**.
- It seems that all government departments involved in natural disasters have their own emergency control center. For instance, GEO, which is heavily involved in landslide disasters, has its own emergency control centre with well-equipped with automatic recording and fall back phones and large display panels, which are connected to the mass media and the internet. CAS also has its own emergency centre, with a system to track and locate their personnel to optimise personnel usage in an emergency.

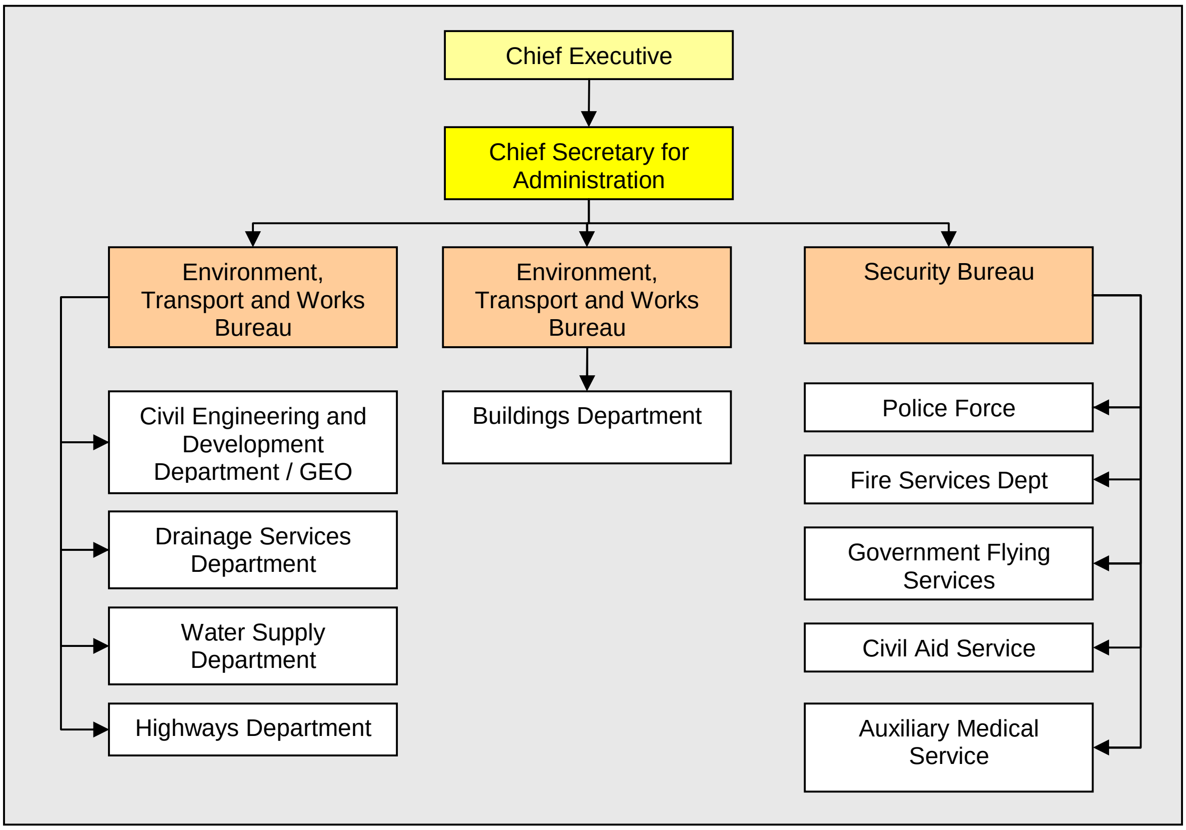


Figure 9.15: Government departments involved during landslide disasters

- All departments involved in landslide disasters have regular training and drills, and this extends down to supporting departments such as CAS. This would be one of the reasons for Hong Kong has a hassle free smooth coordination in disaster management.
- The Hong Kong Government has clearly defined roles and functions of the various stakeholders in landslide disaster management. There the office that has responsibility in landslide incident management is GEO whose responsibilities are clearly stated. This is perhaps one of models that Malaysia should emulate with some modification to fit local needs.
- GEO can issue landside warnings in concert with the Hong Kong Observatory HKO. This is clearly stated. There is no need to consult any higher authority. This is a feature which may be considered; for application in Malaysia.
- GEO is given the task of advising government departments on potential dangers due to landslide and rockfall incidents. GEO provides a 24-hour geotechnical advisory services during landslide emergencies to all government departments. The aim is that there is a department with the expertise to give out such advice.
- GEO not only advises but has the role of providing the measures to deal with emergencies. For example it arranges for the supply of explosives for clearance of boulders and rocks when necessary.
- GEO, like any emergency response stakeholder, is tasked with answering requests for assistance in the saving and protecting of lives.
- GEO's geotechnical engineers are deployed to landslide sites within a specific timeframe. They provide the following:
    - Removal of all immediate and obvious danger.
    - Provide advice to other stakeholders on matters concerning road closures, evacuation, clearance and rescue operations.
    - Advise on emergency works to prevent situation deterioration. Determine on the re-opening or re-occupation of facilities and on the resumption of public facilities to a normal state.
- To be able to handle emergencies in a coordinated and effective manner, a communications system must be in place so that all landslide incidents are monitored and all stakeholders are kept informed of the latest accurate information. This is to enable them to be able to make informed decisions, on how

best to handle landslide emergencies. GEO has its own Emergency Control Centre (ECC); it is activated by the declaration of a landslide emergency. It has in place 13 teams of 11 personnel each, on a roaster basis, to attend to such emergencies.

- GEO's ECC is equipped with the necessary communications technology to monitor all landslides and to keep all stakeholders informed. Their ECC is equipped with the following
    - A database system called the Integrated Landslide Information System (ILIS) that captures the latest monitored information and displays it on large display screens. See **Figure 9.16**.
    - It has a bulletin board system known as the Security Bureau Bulletin Board to enable quick sharing of data with other government departments.
    - The ECC is equipped with plasma display screens to show landslide locations. It has television screens for monitoring news reports.
    - It has a Government Weather Information server to capture the latest weather information including the latest rainfall, radar and satellite images.
    - The centre is equipped to capture the latest data on the rainfall distribution and the latest predictions of possible landslide incidents, based on accumulated experience, through their rain gauge system.
    - In telephony, the ECC has Automatic Telephone Recording system, EMSC fall-back telephones in case ordinary telephone lines fail, direct telephone links for the GEO head to communicate with the emergency team controller.
- To enable improvements in landslide management, GEO has an institutionalised system to require post - incident recording after each declared emergency. This is an area which is absolutely needed to enable lessons learned during an emergency to be distilled for future use.
- Training and drilling forms a big part in enabling the GEO to deliver a consistently high level of operational efficiency. To ensure compliance to set procedures, GEO has published very detailed documented standard operating procedures so that each staff knows what to do in an actual emergency.
- GEO management is trained to handle all media enquiries. This ensures that only accurate information is given out to the media for public transmission. This allows GEO to have firm communications control in a crisis situation enabling GEO to maintain a good public image.

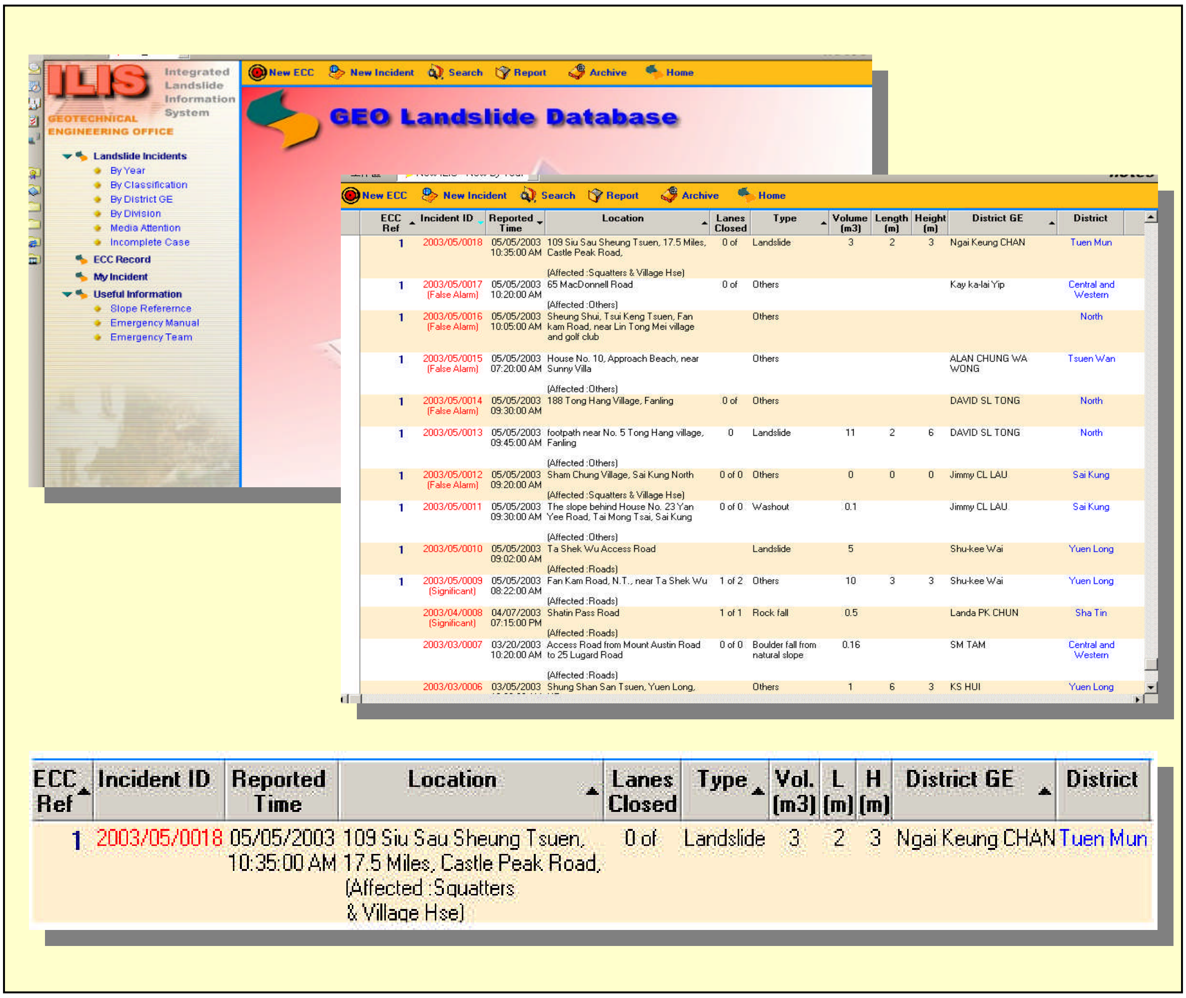


Figure 9.16: Integrated Landslide Information System (ILIS) managed by GEO

<u>What can be emulated from Hong Kong</u>

Hong Kong has a disaster management system allows GEO to effectively respond that works as planned. The system has been fine tuned and deliver the goods during a landslide disaster. GEO officers are media savvy and able to handle public communications in an efficient manner. Their setup incorporates a system to capture lessons learned from each emergency, which this enables them to continuously upgrade their response expertise. They have well-defined job scopes for their officers and detailed standard operating procedures, and this gives their personnel the authority, the motivation and the will to perform up to standards.

GEO procedures and practices in other countries provide benchmarks for prevention, preparation response and recovery and some of the strategies proposed in the study are based on measures and practices taken from these benchmarks.

9.3.6 Equipment and Expertise in Emergency Management

Equipment is essential to aid response and recovery in an emergency. In Malaysia it is often sourced from and utilized by various emergency response agencies such as Bomba, SMART, PDRM, JPA3 and Emergency Medical Services (EMS).

Pertise refers to substantial knowledge and experience in handling the above equipment and having operational knowledge in cooperating landslide emergency.

The equipment that are used vary according to their main emergency response function. For example, the medical services coordinate and despatch ambulances to emergency sites but are limited in medical treatment of injured victims while the fire services will have fire tenders and search and rescue equipment. In this report, equipment and the expertise required by the new agency, SEA will be reviewed and discussed. Technical resources that enable SEA to support the frontline SAR emergency services will be explained in detail.

When addressing a landslide emergency during the response phase, there are two key activities involved: the SAR Operation and the operation of the Emergency Control Centre Operation.

<u>Search and Rescue Operation</u>
SAR operations is are mounted by emergency services to locate and retrieve victims who are buried, trapped and/or injured from the site of the disaster. During the response phase of the disaster, the search and rescue function takes centre stage as all efforts are geared towards locating, and rescuing affected people and treating the injured.

During this time, a geotechnical expert must be available to determine the stability of the disaster site for the safety of the emergency personnel and to ascertain the likely locations of buried victims so that a search area can be delineated.

Search is usually a process spanning many hours or even days, with personnel returning from the site debriefing others to import relevant information to be incorporated into plans for the next personnel deployment. During rescue, immediate medical care is rendered to the victim to stabilize them long enough to be safely transported to the hospital where more intensive medical treatment can be provided.

Emergency Control Centre

The main role of ECC is to monitor, landslide incidents during an emergency or disaster. It is responsible for monitoring and gathering the landslide information such as the size, severity, number of casualties, search and rescue operation and extent of damage. To this end, it should be equipped with the latest information and communication technology (ICT) that allows for the flow of accurate information during a landslide incident, enabling informed decisions to be made on how best to resolve the incident and reporting of the situation to the federal agencies. The ECC should have a communication system which allows information to be shared amongst the incident handlers provides secured access of information by authorised external parties and allows data and images to be directly transmitted to other emergency response agencies for their action. This enables the landslide incident to be handled in a manner best suited to the situation. The ECC system ensures that central command is untied by having all known facts available to the emergency management team to decide upon the course of action while able to keep all involved emergency response agencies and parties informed to minimise effort duplication. Sharing information is the key to effective emergency response, underpinning of cooperation at all levels and across various functions.

Making informed decision on activities based on up-to-date data minimise cost and reduces the impact of the landslide and in many cases saves lives. This is a clear reason why there is a need for an ECC to be setup under SEA. An example of an established ECC is the Hong Kong GEO setup which has an incorporated ILIS system. ILIS is the acronym for Integrated Landslide Information System. Another is the setup by the MLIT Kanto Regional Disaster Centre in the Kanto region in Japan.

ECC Communication Equipment

In addition to the database communication system, equipment must also be considered for smooth flow of communication and data amongst the ECC staff and with other response agencies. Communication systems such as those in Hong Kong and Japan can be considered for a Malaysia setup.

- An AUTOPERS system (automated telephone operating and recording system) that allows a multitude of calls to be handled in sequence; at the same time records the conversations with playback and time stamping capabilities
- Fall-back telephone system in case of failure of land telephone line
- A computer system able to store and update landslide data as it is reported in. The system should be capable of sharing information with other government departments
- An early warning system such as a rain gauge system which updates data every five minutes, with a data retrieval station installed at the emergency control center that displays real-time data collected within the past 24 hours in both graphical and textual format. Ideally the system in place should be able to integrate data from other providers and applications.
- Programmed facsimile equipment that can forward all necessary documents and forms to concerned parties as and when needed
- The possibility of including forward calls to chosen devices
- Share all types of information with voice, web or videoconferencing capability
- Display screens and Interactive screens to show data for viewing and managing purpose.
- Television for monitoring of news reports
- Direct link to the Government Meteorological Department for latest weather condition including forecasted weather for the next three hours.
- Direct telephone line to the National Security Council Disaster Management and Relief Committee.

It is proposed that all relevant emergency response agencies should link to a unified communications system that can be utilised by all agencies rather than to have each agency using a system each according to its own specification.

At the time of this time writing, it was noted that MKN is developing and putting in place a three-tier communication system. This comprises the Government Integrated Radio Network (GIRN) which covers communication amongst the agencies, a dedicated line called Fixed Line Alert System (FLASH) that covers communication such as warning between government agencies and the public and Telekom Malaysia's. 999 line which is communication from the public to the emergency response agencies. Once the system becomes operational, SEA should make itself a part of the 999 system to ensure that it is informed of all landslide emergencies.

9.3.7 The Proposed Equipment

Listed below equipment proposed to be acquired by SEA to support to the SAR activities of the other agencies.

9.3.7.1 Three Dimensional (3-D) Terrestrial Laser Scanning

Terrestrial Laser Scanning (see **Figure 9.17**) consists of sending and receiving laser pulses or echoes from objects to construct a point file of three dimension (3D) coordinates.

Figure 9.17: Terrestrial Laser Scanning

The objects can consist of virtually any dimensional surface. Depending on the technical specifications of the system, the rate of data acquisition can reach up to about few thousands surface points per second. The range accuracy can be plus/minus few millimeters (7mm). The minimum target distance can be few meters (3m) and the maximum target distance can reach about few thousand meters (1500m).

The point file or scan data is transformed into a 3D profile by computer software, which for cross sections can be generated (**Figure 9.18**). Therefore, the surface of structures (e.g., buildings and bridges) or slope faces can be surveyed rapidly and accurately.

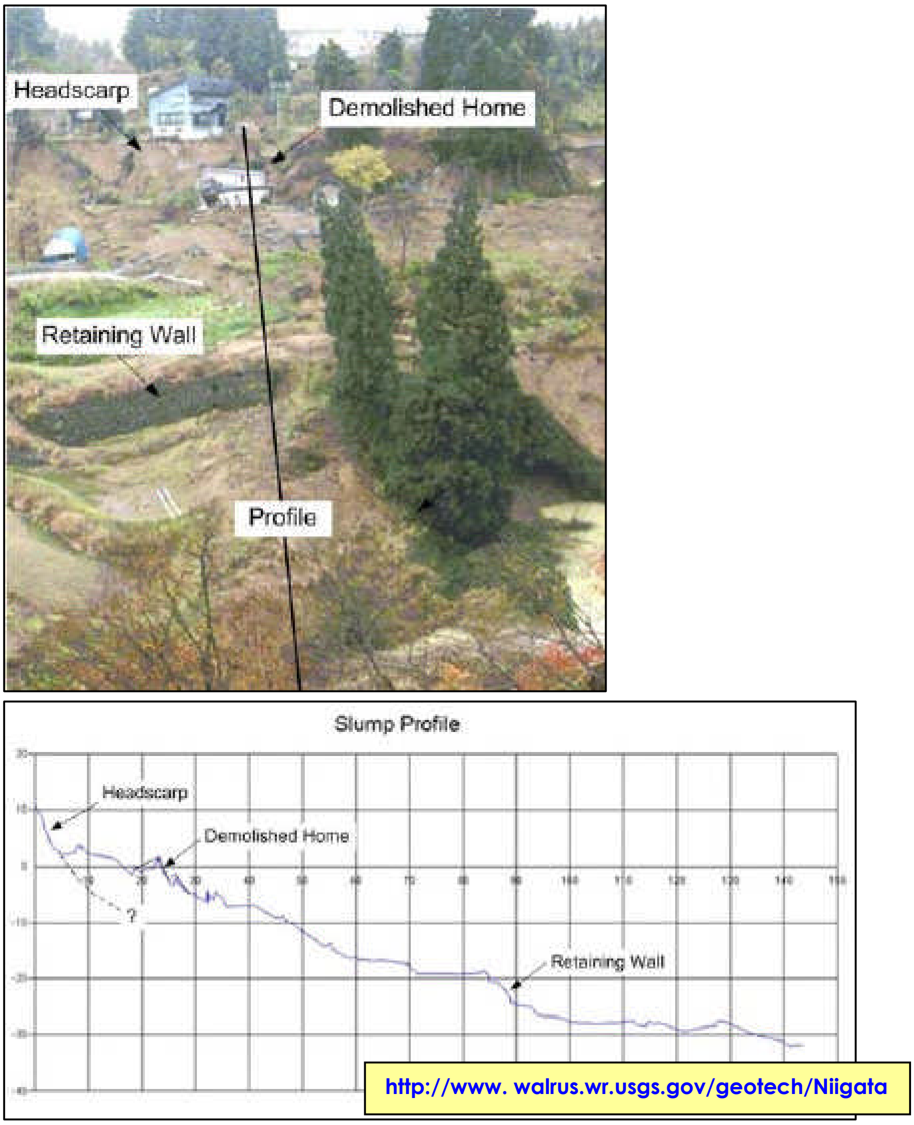


Figure 9.18: **Cross section generated from Terrestrial Laser Scanning**

In addition, the scanning system is able to record the intensity of returned laser light from each shot to produce active laser photographs (see **Figure 9.19**). Some systems are able to record the natural colour of the objects.

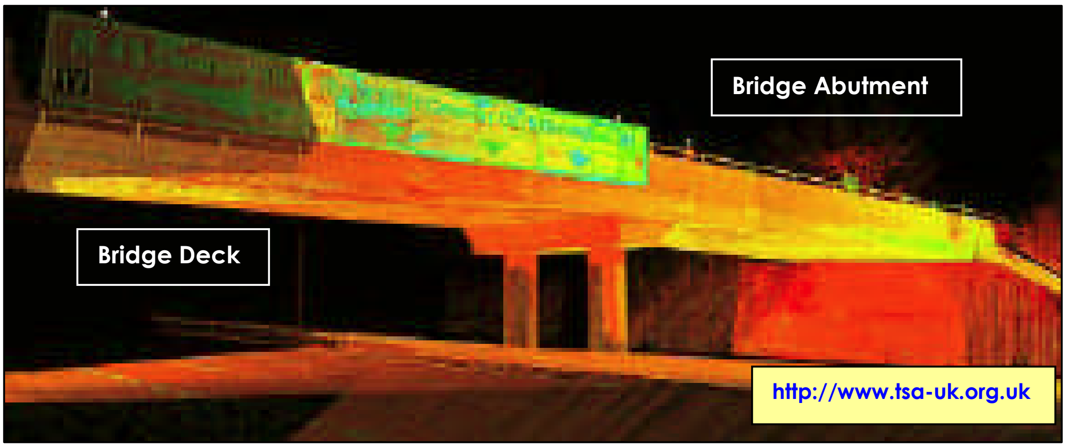


Figure 9.19: **Image of laser photograph**

The data collected using Terrestrial Laser Scanning (TLS) will be processed with local control point. The collected data will be modeled and meshed. Thereafter, a 3D digital terrain model (DTM) will be generated. The sequence of handling and processing the TLS data for landslide monitoring purpose is depicted in **Figure 9.20**.

Terrestrial laser scanning is probably useful for monitoring the landslip scar for further ground movement to ensure the safety of rescuers. Terrestrial laser scanning can also be utilised during the forensic investigation to obtain quick and relatively accurate ground survey data.

Terrestrial laser scanner system is still a developing technology. Hence, some limitations can be expected. Most significantly, it should be noted that the maximum range decreases if the reflecting surface is wet (such as effects of water seepage) or the rock mass has a dark colour surface (Lichti and Harvey, 2002). For this reasons, terrestrial laser scanning should not be a substitute for detailed topographic survey.

PHASE 1a: Specify survey and scanning area

↓

PHASE 2a: Establish Standard Operating Procedure for Terrestrial Laser Scanning (TLS)

- Local control survey
- Determining locality/ suitability of baseline
- Positioning TLS with reference of area
- Perform TLS to produce 3D-DTM in a pre-defined coordinate systems

↓

PHASE 2b: Manage and arrange the point cloud registration data

- Registered point cloud data
- Provide the layout of point cloud by working area
- Registered point cloud with the whole building
- Registered point cloud data required
- Scan world data
- Scan post layer
- Scan post view
- Unified cloud

↓

PHASE 2c: Prepare post processed data

- Cyclone project setup
- Manage the IMP file
- Pre-processing in order to eliminate erroneous and noisy data
- Determination of the global properties of the object's surface, which considers possible generation of the polygonal surface
- Post-processing of the model to refine and perfect the (polygonal) surface

↓

PHASE 3a: Prepare modelled surface for landslide monitoring purposes, this inclusive of Cyclone Modelling process and isolate potential deforming structure in Cyclone:

- TIN model
- Mesh model
- Slope Contour

Source: Proposal for Landslide Monitoring Services Using TLS by Messrs. Geodelta Systems Sdn. Bhd.

Figure 9.20: Terrestrial Laser Scanning (TLS) sequence of data handling and processing

9.3.7.2 Ground Penetrating Radar (GPR)

Ground penetrating radar (GPR) is a non-destructive geophysical method of surface investigation that generates continuous subsurface profile or record of subsurface features without digging, drilling and probing.

GPR operates by transmitting pulses of ultra high-frequency radio waves down to the ground subsurface through a transducer or antenna. The transmitted energy is reflected to the ground surface from buried objects or distinct layers of soil and rock materials. The transducer that receives the reflected wave then stores the data in a digital control unit. The simplified graphical illustration of the GPR operation is shown in **Figure 9.21**.

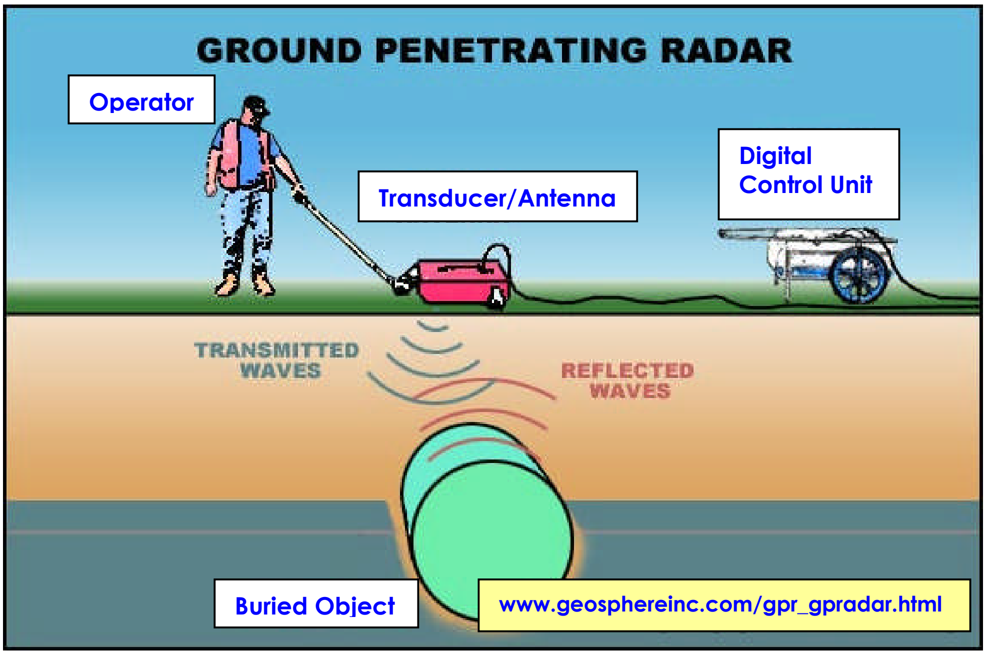


Figure 9.21: Schematic view of GPR survey

In general, a lower frequency transducer (in terms of MHz) will allow deeper depths of subsurface penetration. **Table 9.5** shows the typical transducer frequency associated with approximate depths of penetration for appropriate applications.

Table 9.5: Antenna Frequency Associated With Depth of Penetration

Depth Range (approximate)	Primary Antenna Choice	Secondary Antenna Choice	Appropriate Application
0 – 0.5m	1600 MHz	900 MHz	Structural Concrete, Roadways, Bridge Deck
0 – 1m	900 MHz	400 MHz	Concrete, Shallows Soils, Archaeology
0 – 9m	400 MHz	200 MHz	Shallow Geology, Utilities, Archaeology
0 – 9m	200 MHz	100 MHz	Geology, Environmental, Utility, Archaeology
0 – 30m	100 MHz	Sub-Echo 40	Geologic Profiling
Greater than 30m	MLF 80, 40, 32, 20, 16 MHZ	20 m	Geologic Profiling
Source: www.geophysical.com			

The suitable application of the GPR during the response phase of a landsliede disaster is the detect ion of the depth of groundwater table to ensure that immediate measures can be undertaken to install effective subsurface drainage such as horizontal drain at critical areas. In addition, the GPR survey may be useful to delineate the soil and rock strata for immediate or temporary remedial works to be undertaken. For instance, the depth of the hard stratum has to be identified before temporary sheet piles are installed.

GPR survey can also be used to determine the depth and thickness, and characterisation of soil and bedrock (see example of cross sectional image in (**Figure9.22**). In addition, the profile of slip circle or position of weakness zone of a landslide can be represented as an ‘anomaly’ in the cross-sectional image. This method is useful during forensic investigation to know the extent of a slip circle.

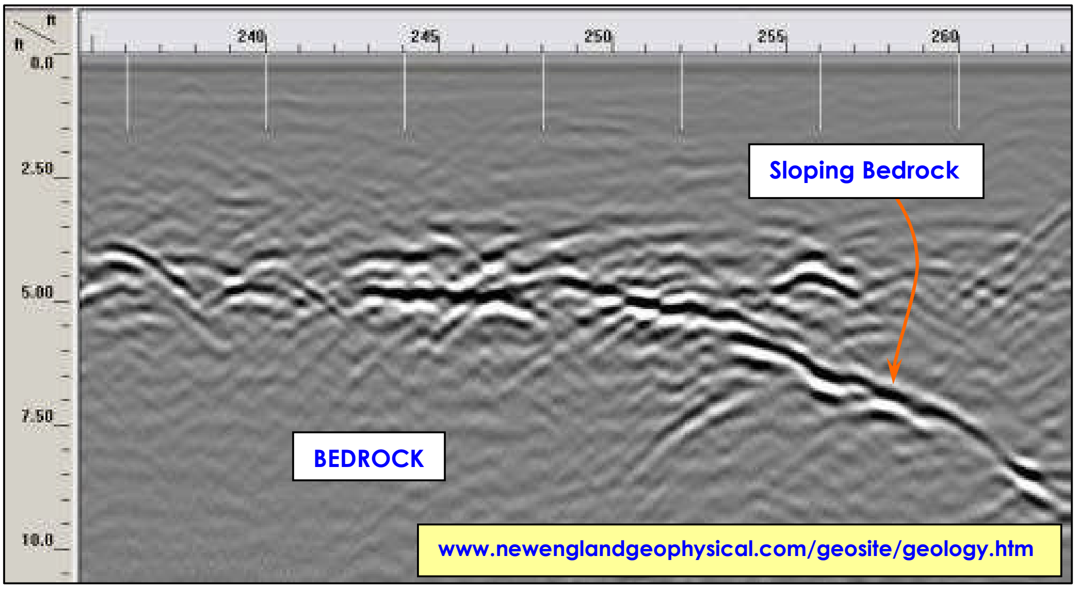


Figure 9.22: Subsurface Scan Image

The U.S. Army Corps of Engineer (USACE) has published a detailed list of GPR limitations by assigning numerical ratings for engineering application as shown in **Table9.6**.

The U.S. Environmental Protection Agency (EPA) also highlighted some of the GPR limitations as follows:

- Site-specific performance
- Depth of penetration is limited by the presence of conductive clays or high conductivity pore fluid
- Interpretation of GPR data requires a highly trained operator

In the local context, GPR survey is probably not suitable in areas that are underlain by sedimentary rock formation (particularly those comprising mudstone and shale).

Table 9.6: Numerical rating of GPR to provide specific engineering parameters*

Nos.	Engineering Parameters	Numerical Rating				
		0	1	2	3	4
1.	Depth to rock				√	
2.	P-wave velocity	√				
3.	S-wave velocity	√				
4.	Shear Modulus	√				
5.	Young's Modulus	√				
6.	Poisson's Ratio	√				
7.	Lithology		√			
8.	Material Boundaries Stratigraphy				√	
9.	Dip of Strata			√		
10.	Density	√				
11.	In Situ State of Stress	√				
12.	Temperature	√				
13.	Permeability			√		
14.	Percent Saturation				√	
15.	Ground water Table				√	
16.	Ground water Quality	√				
17.	Ground water Aquifers	√				
18.	Flow Rate and/or Direction			√		
19.	Borehole Diameter	√				
20.	Obstructions				√	
21.	Rippability	√				
22.	Fault Detection				√	
23.	Cavity Detection				√	
24.	Cavity Delineation				√	
25.	Location of Ore Bodies				√	
26.	Borehole Azimuth and Inclination	√				
Source: Table 4-2 of pg 4-10 from USACE (2001) Engineering and Design – Geotechnical Investigations, EM 1110-1804, Dept. of the Army, Washington DC.						

Notes:
* – Numerical rating refers to applicability of method in terms of current use and future potential:

0 = Not considered applicable
1 = Limited
2 = Used or could be used, but not best approach
3 = Excellent potential but not fully developed
4 = Generally considered as excellent approach; state of art well developed

9.3.7.3 In-Place Inclinometer

The in-place inclinometer is a device to monitor the landslide areas as the mean to provide early warning of impending slope failure. It is also applicable for determining the deformation of retaining walls and deflection of laterally loaded piles.

The system consists of the placing sensors in the installation casing of a vertical borehole. The sensors are connected to a data logger which can trigger an alarm based on the rate of deformation or change. The advantage of this system is the ability to deliver readings in near real time without any attendant monitoring by an operator or technician.

During the response phase, the in-place inclinometer is useful for measuring the lateral displacement of the soil or rock structures to determine stability of slopes. This is to ensure the safety of rescuers as the alarm system will provide relatively ample time for the rescuers to take whatever action is necessary.

The in-place inclinometer is also useful for determining the performance of the slope after the remedial measures have been undertaken.

There is a relatively new technological system known as ShapeAccelArray™ (see **Figure 9.23**) that could be considered to replace the conventional in-place inclinometer.

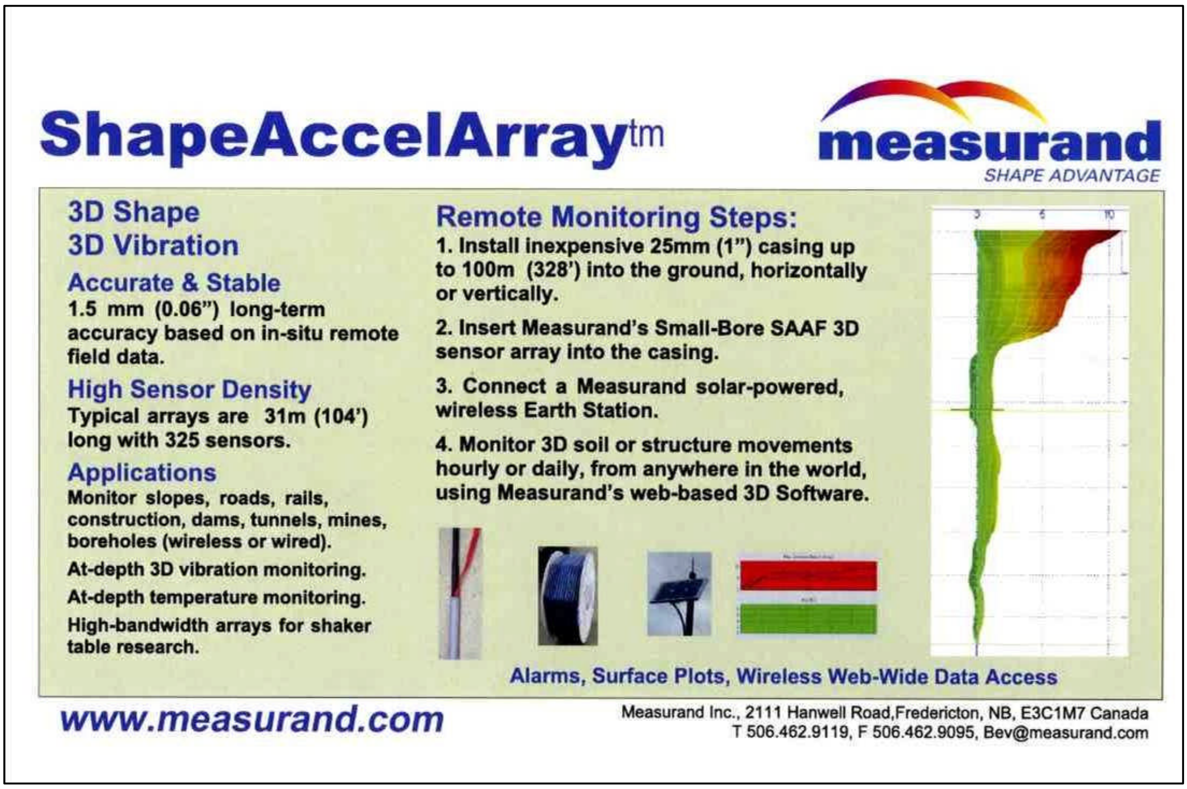


Figure 9.23: An overview of ShapeAccelArray™

The conventional in-place inclinometer consists of a series of probes fitted with guide wheels and each comprising a tilt sensor (**Figure 9.24**), whereas the ShapeAccelArray™ has a relatively high sensor density (a typical model has a 31m long array and the cable has 325 sensors). For the conventional type, there is a limit to the number of sensors in each installation due to cost as it escalates proportionally to the number of sensors.

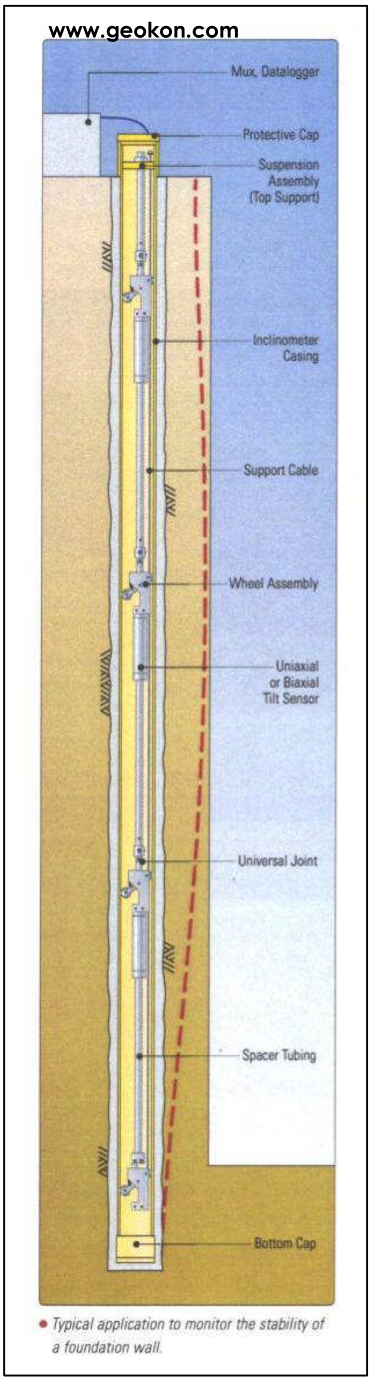


Figure 9.24: In-place inclinometer (conventional type)

9.3.7.4 Software for Engineering Control of Landslides

Introduction

Geotechnical software is used for the accurate and rapid analysis of soil and rock slope stability. The analyses of slopes are conducted for two different objectives:

- To obtain strength parameters along failure surfaces by back-analysis
- To design the remedial measures

List of Software Packages

A common list of the available commercial software packages is shown in **Table9.7**.

Table 9.7: List of Commercial Software

Software	Description	Cost (USD)/unit
DIPS	Graphical and statistical analysis of geological orientation data/stereonet plot	595.00
ROCFALL	Statistical analysis of rockfall	795.00
ROCPLANE	Planar sliding stability analysis for rock slopes	595.00
SWEDGE	3D surface wedge analysis for rock slopes	1,195.00
ROCKPACK	Stereonet plot, including planar, wedge, and toppling analysis for rock slopes	1,000.00
SLOPE/W	2D limit equilibrium slope stability analysis	4,495.00
SLOPE/W SEEP/W SIGMA/W	'Bundle' software capable to perform rigorous finite-element analyses	8,995.00
Software for Engineering Control of Landslide and Tunnelling Hazards*	Note: * - Title of academic book authored by Bhawani Singh and R.K Goel, and published by A.A Balkema Publishers (2002); contains a suite of DOS related programs consisting of 'joint analysis, planar slides, wedge slides, toppling failure and circular slide.	200.00

9.3.7.5 Very Small Aperture Terminal (VSAT)

Introduction/ Applications

There is a need for a cost-effective communication link between the ECC and the field in landslide operations for both urban and remote areas. Here we look at a Very Small Aperture Terminal communication system.

Very small aperture terminal (VSAT) is a satellite communications system, which can be used during the landslide response phase. It serves as a link of communication between the ECC and the mobile unit, which is based at the landslide area.

VSAT systems can be programmed to provide communications support for various types of applications such as high speed Internet access, transfer data, private line voice and video signal. With VSAT, the mobile unit is operational even in remote areas as communications can be relayed through the Internet. **Figure 9.25** shows an example of a VSAT communications system as designed by Intelligent Promenade Sdn. Bhd. a telecommunications speacialist. The figure shows that the VSAT flyaway antenna transmits and receives information from the mobile unit or remote station through satellite to the earth station hub and to the ECC.

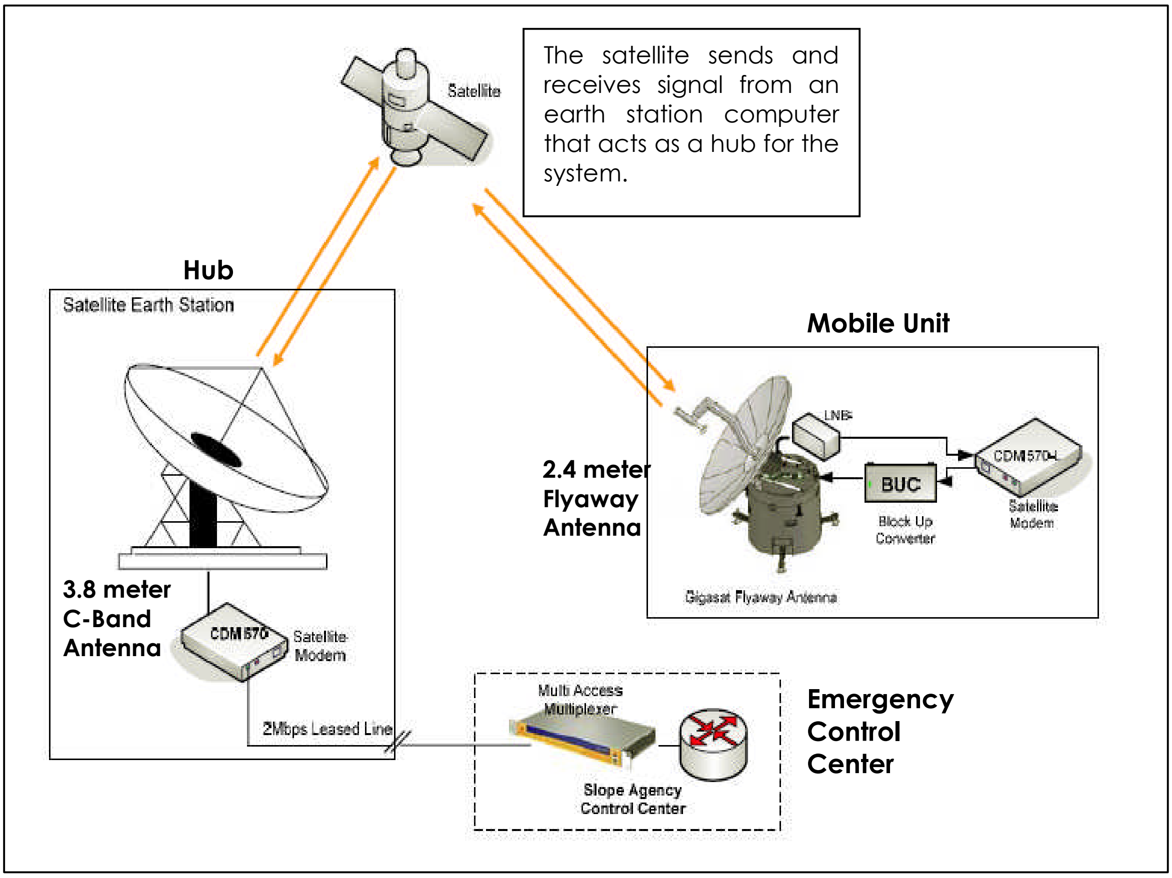


Figure 9.25: VSAT communications system

The **2.4m flyaway antenna** is specifically chosen for its robustness and particularly built for rapid deployment in a remote area. It can be easily setup by two people on site (see **Figure 9.26**). The flyaway antenna possesses the following advantageous features:

- Comprehensive: set of modules ready-made or custom-built to serve most transmission and communication needs with enhanced performance and reliability
- Lightweight: lightest possible weight with structural strength and integrity
- Compact and transportable: can be packed as airline checked baggage (complies with IATA regulations)
- Quick deployment: can be set up within 30 minutes
- Rugged: suitable for all weather and terrain

The **3.8m C-Band antenna** is specifically designed to ensure mechanical robustness, operational reliability and flexibilityfor future expansion. The C-Band earth station can support the following applications:

- Video broadcast
- VSAT system for voice, image, and data
- Internet backbone
- VSAT Flyaway satellite communication

Preliminary Cost Data

The preliminary costing of a complete 2.4m Flyaway Antenna System with accessories and the 3.8m C-Band Antenna (of single unit) with accessories is shown in **Table 9.8**.

Table 9.8: Summary of VSAT costing

Nos.	Item Description	Quantity	Unit Price (RM)
1.	2.4m flyaway antenna	1	545,300.00
2.	3.8m C-band antenna	1	236,300.00
		Total	781,600.00

Figure 9.26: **Installation of flyaway antenna**

9.3.7.6 Heavy Equipment

Landslides always involve the movement of earth and rocks. The removal of this displaced debris is one task which all emergency response teams undertake, in particular by the search and rescue teams from the fire services and the civil defence agencies. The quick removal of the displaced soil requires the deployment of earth moving equipment such as excavators, bulldozers, wheel loaders and trucks. Depending on the area of disaster, as in an urban area, a short radius excavator that can operate in tight areas between buildings maybe needed. The problem is to mobilise such equipment within the shortest possible time as time is critical for the injured and the buried.

As stated, various types and numbers of heavy equipment are required in a landslide emergency, depending on its type and extent. The decision is whether to acquire such equipment or not. If the answer is affirmative, another decision has to be made on which emergency response agency shall do the purchase. Then the decision of the types to be acquired has to be made by the emergency response agency that is tasked with the role of operating the equipment.

After studying the issue, a few facts (other than the ones listed above) emerged which points to the best possible solution. The facts are:

- The high risk prone landslide areas are situated in or near areas of high urban conurbations or in areas of massive land development where there are many changes in the landscape and slope configuration through cut and fill activities.
- These areas have a high number of earth moving equipment owned by private owner operators.
- If any earth moving equipment is acquired by emergency response agencies, its usage will be limited to only a few times a year; this means that they will be idle most of the year. This has to be balanced against the heavy financial cost of acquiring them.
- If these equipment are acquired, it would be practical to park them in emergency response agencies such as Bomba and JPA3 which may have storage space.
- These agencies have technicians maintaining their equipment such as fire tenders, ambulances and other transporters, and they can be easily trained to maintain earth movers.
- These agencies already have mobilisation capability in moving large equipment to disaster areas.
- These agencies are the ones who require this equipment for SAR work.
- Both of these agencies have stations in or near high risk prone landslide areas.

The possible solutions are varied and can be combined:

- Have a formal agreement between private owner operators such that their services can be co-opted in a landslide disaster.
- They will be paid promptly within an agreed-upon time period.
- The personnel in charge of SAR activities are given the authority to engage these owner operators as he sees fit.
- The agencies have a continuously updated list of these owner operators to contact them to engage their services as and when needed.
- If a decision is made to acquire such equipment, it is best that they be acquired by the fire services or JPA3.
- It is noted that one of main tasks of SEA to have a formal mutual inter-agency cooperation agreement to facilitate inter–agency response to landslide and to conduct inter-agency drills. Such round table discussions can address issues and come up with decisions based on input from relevant bodies.

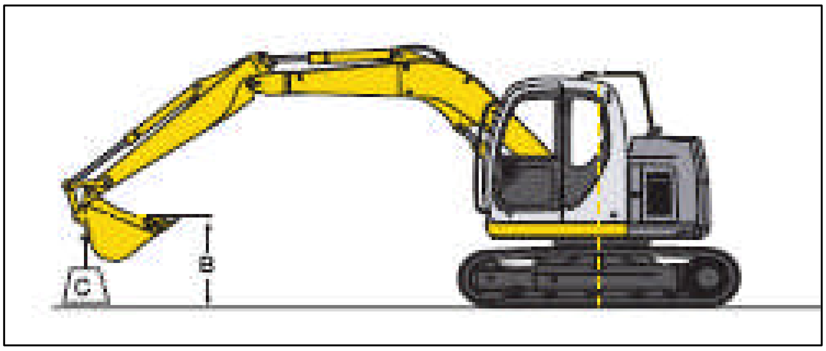


Figure 9.27 Graphic picture of a track type excavator

Cost Data

It should be noted that a 20-tonne excavator costs RM350,000.00 and a 36-tonne has a price tag of RM 650,000.00, and a major landslide disaster would require many more such equipment in addition to other earth movers. Given the high cost of equipment, purchasing decisions should be made after the formation of SEA.

Suppliers List

- Kobelco Construction Machinery Malaysia Sdn. Bhd., Lot PT 556 Persiaran Sabak Bernam, Seksyen 26, 40400 Shah Alam, Selangor Darul Ehsan.
  Tel: 03 - 5192 7533

- Tractors Malaysia Sdn. Bhd.
  1 Jalan Puchong, Taman Perindustrian Puchong Utama,
  47100 Puchong, Selangor Darul Ehsan.
  Tel: 03 - 8068 8000

- Hitachi Construction Machinery Malaysia
  Lot 7, Jalan SS13/2, Subang Jaya Industrial Estate, 47500 Petaling Jaya, Selangor Darul Ehsan
  Tel: 03 – 5568 6000

- UMW Equipment Sdn. Bhd.
  Jalan Utas (15/7), 40915 Shah Alam, Selangor D. E.
  Tel: 03 - 5163 5000

9.3.7.7 Ambulance Specifications

Detailed below is a typical Type B specifications for ambulances. Type B specifications is the most common type as it meets most medical requirements in the transportation of affected victims. As noted, below the main difference between a Type B 4x2 ambulance and a Type B 4x4 ambulance is the mounting of the ambulance body on to a 4x4 light truck chassis. The typical Type B ambulance specifications is presented in **Appendix 1**.

Cost Structure

The specifications shown in **Appendix 1** are of a type B ambulance with a 4x2 chassis. The aforesaid specifications are the JPA3 specifications for their type B ambulance. One reason for detailing the above is that JPA3 is the only agency that provides both rescue and emergency medical services in the country. The cost is approximately RM 200.000.00. The same specifications can also be applied for a model with a 4x4 chassis. The cost will then be approximately RM 250,000.00. This takes into account the additional cost of a 4-wheel drive chassis and additional strengthening of the ambulance body. Cost varies depending on the fittings. A Type A ambulance on a 4x2 chassis will cost approximately RM 500,000.00.

9.3.7.8 Hospitals for Emergency Preparedness

The complete list of government hospitals is shown in **Appendix 2**. With a formalised mutual inter-agency cooperation, such a list is crucial to prepare hospitals near the landslide-prone areas to better cope with landslide casualties.

9.3.8 Proposed Control Centre and Regional Offices

After further consideration, an Emergency Control Centre for Landslide is proposed to be located at the SEA headquarters. Regional offices will need to be set up at landslide-prone areas to ensure a response time of two hours at these locations. Existing landslide-prone areas are already being identified by the Hazard Mapping component. These landslide-prone areas are identified based on landslide history occurrence data. **Table 9.9** below which shows the number of reported landslides and fatalities could also provide a guide on where the regional offices need to be located.

Table 9.9: Reported landslides and fatalities according to states

State	Total Landslides	Cases with Fatalities	Total Fatalities
Kuala Lumpur	94	4	61
Selangor	78	3	52
Perak	64	5	84
Pahang	58	6	50
Negeri Sembilan	30	0	0
Sabah	30	3	322
Pulau Pinang	24	0	0
Johor	20	2	6
Kelantan	18	2	2
Sarawak	17	4	22
Kedah	16	1	2
Terengganu	8	0	0
Melaka	3	0	0
WP Labuan	3	0	0
Perlis	2	0	0
WP Putrajaya	1	0	0
Total	**466**	**30**	**601**

The forecasted future landslide areas also need to be considered, so that the offices will cater for the possibility of landslide occurrences in those areas in the future. The map showing the future conurbation areas in **Figure 9.28** points to possible future landslip areas as these are the areas that will see massive developments in the next few years.

Therefore, the offices should be located at strategic places to cater for both existing and future landslide-prone area as seen in **Figures 9.29a – 9.29b**. A central regional office could cater for Selangor and Kuala Lumpur landslide areas with its operational area even encompassing the Mentakab region in western Pahang due to land route considerations and the area's geographic proximity to the Klang Valley. The same land route consideration will likely make it be responsible for the Cameron Highlands area and its adjacent regions of central and southern Perak state. Another regional office should then be located in the Northern Peninsula Malaysia to cater for northern landslide areas such as those in Penang, northern Perak state. Eastern Peninsula Malaysia should have one office to cater for possible landslides in the eastern side. Southern Peninsula Malaysia should have one, since Johor is already a landslide-prone area and currently undergoing rapid expansion in population and development. Sabah and Sarawak should each have one regional office due to their size. **Figure 9.30** shows the ideal locations for the regional offices.

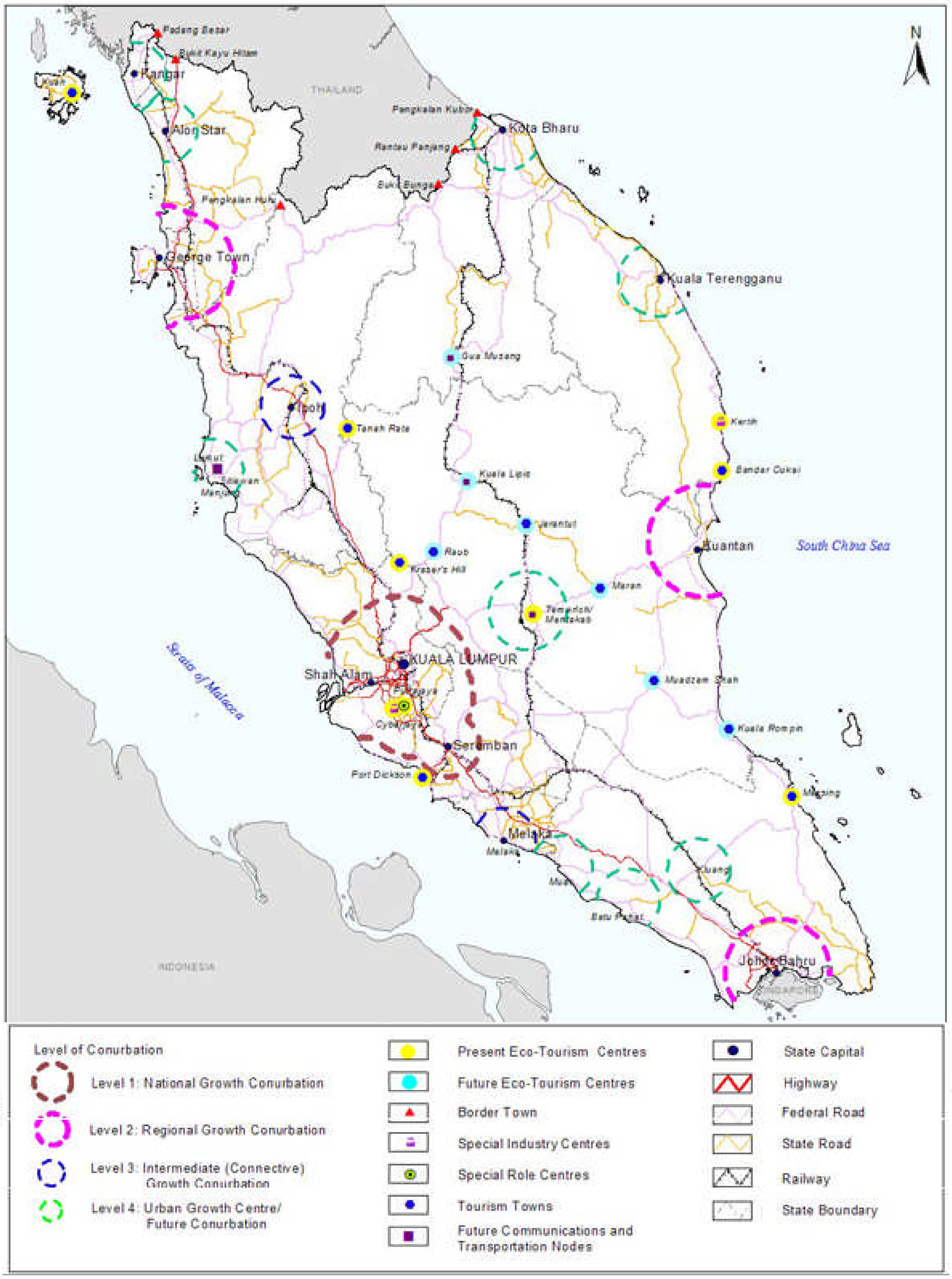


Figure 9.28: Future conurbation locations

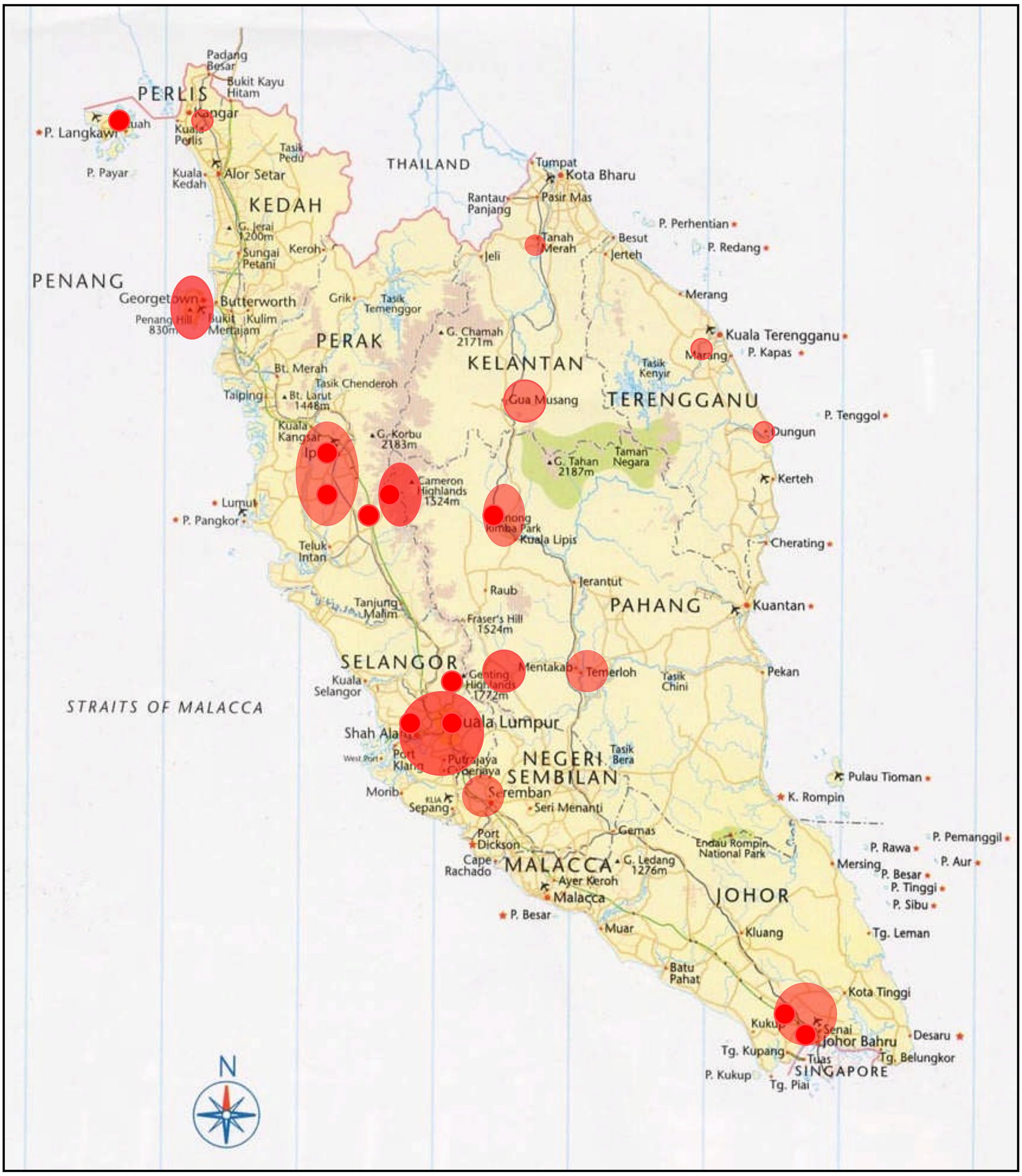


Figure 9.29a: Landslide-prone areas in Peninsular Malaysia

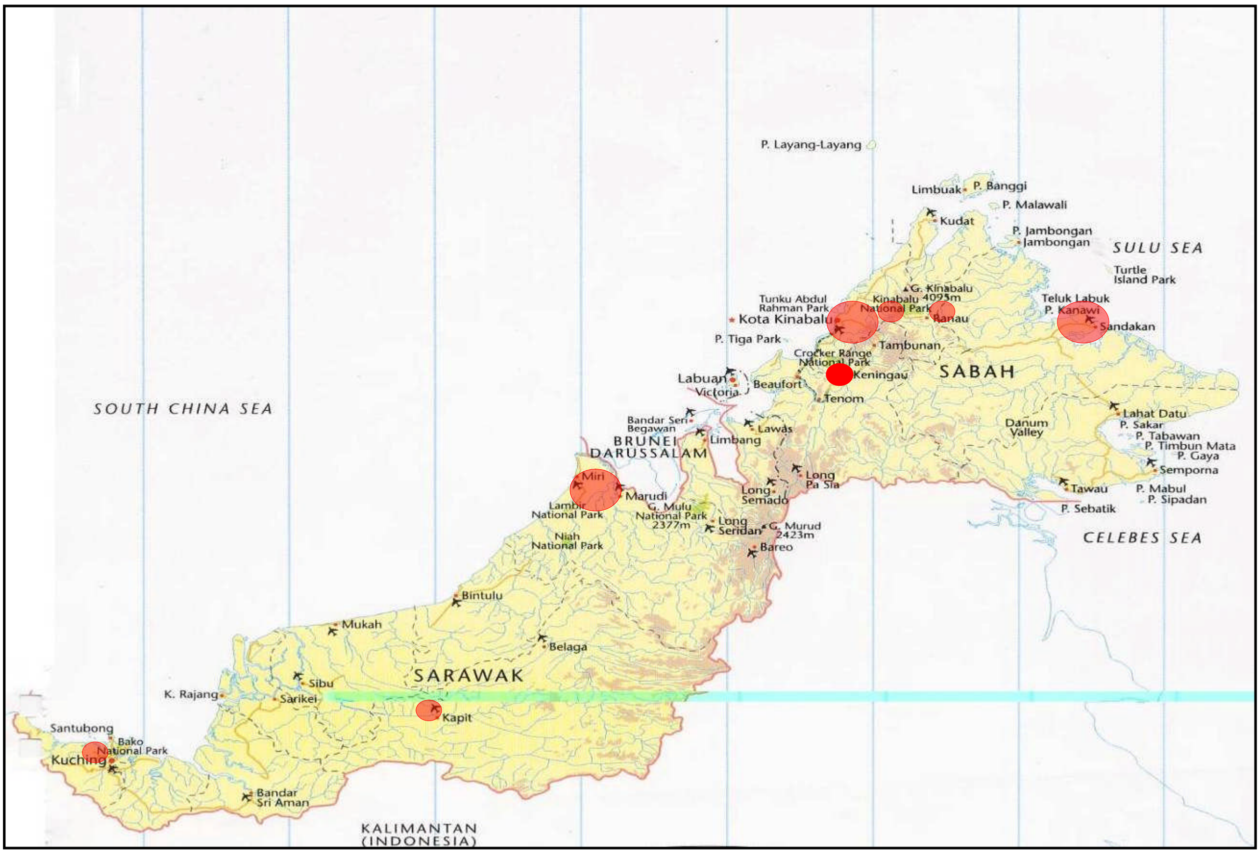


Figure 9.29b: Landslide-Prone areas in Sabah and Sarawak

Figure 9.30: Proposed regional offices for SEA

9.3.9 Proposed EPRR Expertise

This section identify us and lists some of the main specialist expertise that is needed in order to perform the supporting services that will be provided by SEA. The main specialist staff would include geologists and geotechnical engineers, who shall carry out forensic investigations after a landslide or monitoring of landslide - prone slopes which is part of proactive measures in a landslide management program.

The task specifications listed below are intended to present a general list of the range of duties that will be performed by such staff members. However, the list is not exhaustive and other duties may be included at a later time.

Geotechnical Engineer
A geotechnical engineer in slope engineering and slope stabilisation applies the sciences of soil and rock mechanics, engineering geology, and other disciplines to civil engineering design and construction, whilst working to preserve and protect the physical environment.

Geotechnical engineers working within SEA shall collect data such as water table data, soil conditions, water seepage etc. and subject such data to their analytical skills to determine slope stability and the possibility of slope failures. Working in a team alongside geologists, geological engineers and hydrogeologists, they focus on providing information and solutions to ensure that slopes remain stable and intact.

Geotechnical engineers in SEA will work in areas such as soil investigation, slope stabilisation studies, forensic investigations and landslide site investigations and foundation engineering. Activities include

- Gathering data such as water table data, soil conditions, water seepage to determine integrity of slope conditions
- Undertaking desk studies, assessing sources of site information; and studying geological maps and aerial and satellite photographs to help determine slope movements;
- Using specialist computer software
- Ascertaining the safety level of landslide site commerce SAR

- Overseeing the progress of slope stabilisation and monitoring works of slopes
- Investigating site and or ground conditions
- Managing staff, including other geologists, geotechnical engineers, consultants, and contractors
- Attending professional conferences and representing SEA at other events
- Creating two and three-dimensional analytical models
- Making complex calculations in planning or assessing structures

Activities of a geotechnical engineer under SEA carrying out emergency duties at a landslide disaster are as follows

- On arrival at the site, the geotechnical engineer will make his inspections and gather and record as much information as possible, This includes taking photographs of all important features of the landslide. Then based on the findings of his inspection, makes a decision and gives advice based on the geotechnical aspects of
- The possible danger of a landslide reoccurrence, i.e slope failure, retaining wall failure or rock falls
- The safety of the occupants of the affected and adjacent buildings and other structures.
- The safety of rescue workers and fire fighting personnel
- The safety of the general public generally.
- The safety of the affected and adjacent buildings, roads and other facilities
- The types of emergency measures or actions that is practical to implement to allay the danger of further or immediate failure
- The need for continuing surveillance of the area of concern

<u>Geologist</u>

Geologists study the earth's crust through examination of the rocks, soil, and minerals contained within an accurate picture of its structure, history, and composition. At SEA, the geologist applies geological knowledge to engineering problems encountered in land development projects, especially in slope construction and in related construction projects. Activities include the following:

- Examining the slopes, both man-made and natural , to determine the sequence of processes affecting development of slopes to ascertain if the slope is landslide - prone or not. The geologists' findings are then used to propose recommendations for ensuring slope stabilisation through protective measures
- Gathering data such as water table data, soil conditions and water seepage to determine integrity of slope conditions
- Undertaking desk studies, assessing sources of site information land studying geological maps and aerial and satellite photographs to help determine slope movements
- Preparing geologic reports and maps, interpreting research data and recommending further study or action
- Using geologists' findings to come up with recommendations to ensure slope stabilisation through protective measures

<u>Geophysicists</u>

Geophysicists apply their knowledge of the principles and techniques of geophysics and related sciences in the investigation, measurement, analysis, evaluation, and interpretation of geophysical phenomena and artificially applied forces and fields related to the structure, composition, and physical properties of the earth and analyses data to estimate composition and structure of the environment surrounding slope development. They also investigate the origin and activity of landslides. Activities include.

- Using equipment to collect data on earth movements and seismic waves
- Controlling data quality by monitoring displays and performing some initial interpretation
- investigating development sites such as slopes and landfill sites using geophysical techniques
- analyzing data to arrive at findings of slope development
- provides information to the public and government

Typical work activities include:

- Pre-planning projects before going onpsite;
- Deciding on suitable seismic measurement and data processing techniques
- Taking equipment out to various locations
- Observing the reaction of recording equipment to detect irregularities

- Using computers for data management, quality control and communication
- Interpreting and reporting on collected data
- Thinking quickly and independently to solve problems
- Adapting data collection procedures
- Working closely with other staff to compile charts and reports
- Writing documentation and work logs
- Communicate with clients, senior managers or partners at meetings and presentations

Geographic Information Systems (GIS) Officers

Geographical information systems (GIS) are computerised systems for the collection, analysis, storage and manipulation of complex geographical information. The GIS officer SEA is considered a professional with a working knowledge of the assigned industry/technical field in which SEA operates such as environment studies slope studies construction. Positions at this level serve as a technical resource providing technical support and analysis to a functional area. The head of the GIS manages various teams of IT specialists and GIS officers in areas such as in environment studies as in slope studies and construction.

GIS managers oversee the production of data to help plan and deliver many different services. They do not necessarily undertake a great deal of technical work themselves, but work mainly as project managers, leading and coordinating the work of the team.

The geographical data they work with is likely to be a combination of topographical information and social and economic data. These data and the situations are evaluated using specialised technical concepts.

Projects and teams are varied in this profession, so a typical role for a GIS manager can be difficult to define. However, there are many activities which are likely to form part of the job these work activities do present a descriptive list of the range of duties performed by employees in this class. The specifications are not intended to reflect all duties performed within the job. These include

- Bringing together and managing multidisciplinary teams of programmers, systems analysts, cartographers and data managers to work on particular projects

- Managing teams on a daily basis;
- Resolving problems and queries as they arise;
- Overseeing the application of specialist information management computer programs;
- Designing, updating, implementing, and managing GIS software applications for deployment of maps and their related information in paper, digital, and web format
- Coordinating all data sharing as well as report and map generation for different departments, agencies, and consultants
- Supervising, reviewing, and verifying the work of staff responsible for creating, gathering, and manipulating pertinent geographic data for accuracy, proper work methods, techniques, and compliance with applicable standards and specifications
- Analysing and interpreting geographic data
- Interpreting plans, photographs, maps, and legal descriptions
- Coordinating GIS data conversion and cartographic production activities; prepares maps, drawings, spreadsheets, data files, and other documentation.
- Developing and creating GIS layers/data elements consistent with existing standards; performs digitizing and drafting as required; codes and digitizes maps and geographic feature data into various layers with the GIS
- Using the information gained to make informed decisions about the use of resources;
- Liaising with clients to clarify the nature and purpose of the information they require
- Communicating between clients and the team providing GIS services
- Managing project costs
- Ensuring that project deadlines are met
- Facilitating the sharing of information across different departments within an organisation

The above duties are typical for this classification. Incumbents may not perform all of the listed duties and/or may be required to perform additional or different duties from those set forth to address changing operational needs and practices.

9.3.10 The New Agency Role in Landslide Emergency

In this overview, the normal actions that is initiated in the three phases of emergency management i.e preparedness, response and recovery in which EPRR is to be designed to handle is detailed table format. The three charts depict the normal actions of emergency management in the three phases mentioned. The new agency, SEA, will be tasked with providng supporting service to the main emergency response agencies such as Bomba, SMART, and Civil Defence, in addition to state and local jurisdictions. The national frameworks for preparedness, response and recovery are depicted in **Tables 9.10**, **9.11** and **9.12.**

Table 9.10: Landslide Preparedness Framework

LANDSLIDE PREPAREDNESS FRAMEWORK		
Establish policy and mechanism SEA to be the Authority on landslides Apply to be part of GIRN. "999" to call SEA on landslide emergencies 2yrs minimum service for emergency personnel	**Preparation of guidelines/ Standard Operating Procedures (SOP)** Prepare guidelines on landslides Assist MKN to prepare SOP for landslides Explore new technologies to assist in recovery efforts	**Procurement of equipment, expertise, and material** Issue Hazard & Risk Maps to Bomba, SMART, JPA3, MOH and JKR Purchase necessary equipment for SEA Compile a list of panel consultants, suppliers and contractors
Regular coordination meetings Attend Disaster Management and Relief Committee meetings	**Conduct training and drills** Advise MKN on landslide drills Conduct internal simulation exercise Sent staff for training and missions overseas	**Establish temporary shelters** Issue Hazard & Risk Maps to JKM
Conduct checks on equipment and machineries Calibrate equipment according to maintenance schedule and ensure that they are operational	**Conduct checks on emergency personnel** Physical and mental alertness test on emergency personnel	**Conduct checks on emergency contact numbers** Regular checking on contact numbers listed in the Emergency Response Plan

Notes:

1. – Proposal for the procurement of specialised equipments:
   - Terrestrial Laser Scanner system ('Ground LiDAR') for slope monitoring purpose to ensure the safety of rescue personnel, and to obtain immediate survey data.
   - Ground Penetrating Radar (GPR) for rapid subsoil profiling to ensure adequate input for immediate stabilisation works.
2. – By Social Welfare Department/ Local Authority

Table 9.11: Landslide Response Framework

LANDSLIDE RESPONSE FRAMEWORK		
Immediate mobilization to site Mobilize to site within one hour Seek confirmation on the reported incident Estimate the overall magnitude of the damage Estimate the additional support from other sources or agencies if required	**Establishing On Scene Command Post (OSCP)** Report to the Incident Commander (under directive of MKN 20) Advise the Incident Commander on proper zoning Mobilize Landslide Mobile Control Centre if required	**Recovery of buried victims** Provide technical advice to other agencies (SMART, BOMBA, and JPA3) during search and rescue operations. Ensure safety of other agencies by continuous monitoring of ground movement and geotechnical analysis
Evacuation Provide technical advice to the Chairman of DMRC on the evacuation plan, if necessary		**Slope stabilisation works** Propose immediate or temporary stabilisation works and manage the works, if required
Ground survey Propose topographic survey using GPS, total station or Airborne/Ground LiDAR Commission relevant agencies to provide aerial photographs (from JUPEM or other service providers) and satellite images (from MACRES)	**Geotechnical/Forensic investigation** Establish chronology of events. Carry out Subsurface Investigation Carry out site reconnaissance, fieldwork, field instrumentation, rock slope mapping and geomorphic mapping Carry out detailed forensic analysis	**Geotechnical Design (if required)** Determine soil/rock parameters Define rock or subsoil profile Carry out detailed analysis and design of proposed remedial works

Notes:

3. MKN 20 – National Security Council Directive No. 20 on 'Policy Mechanism Of National Disaster Management And Relief'
4. SMART – Special Malaysia Disaster Assistance And Rescue Team
5. BOMBA – Fire And Rescue
6. JPA3 – Civil Defence
7. JUPEM – Department of Survey And Mapping
8. MACRES – Malaysian Centre For Remote Sensing

Table 9.12: Landslide Recovery Framework

LANDSLIDE RECOVERY FRAMEWORK		
Provision of food and temporary shelter Advise on possible duration of evacuation	**Allowing public to reoccupy buildings** Give clearance for the public to move in after detailed investigation	**Issuance of Forensic Investigation Report** Issuance of Forensic Report to those affected
Rectification works (long term measures) Assist in remedial works, if required	**Reopening of roads / highways** Give clearance for reopening of roads after detailed investigation	**Provision of counseling services** Provide expert advise or conduct lecture, if required

Notes:

1. – Recovery **phase also includes the implementation of Forensic Investigation, thus occasionally overlapping with the response phase.**
2. – By Social Welfare Department/ Local Authority.
3. – By the Local Authority.

Following the above, a more detailed guideline on how the new agency will respond to these tasks is described below.

9.3.11 The Emergency Guidelines to Landslide Emergency

Search And Rescue in Landslide Response Operations

A more detailed proposal guideline is provided for the Search and Rescue component of the Response phase in emergency management. The guidelines are given in the form of what needs be done or duties that have to be effected.

Safety of Rescuer

The issue of safety during the search and rescue operation is crucial, as lives of rescuers can be jeopardised, whereby the casualties of the rescuers will eventually undermine the rescuing efforts.

In order to minimise the risks of exposing the rescuers to dangerous situations, new SEA shall mobilise an emergency landslide response team to provide on-site assistance or technical advice to the various rescue agencies. **Figure 10.32** gives an indication of some type of advice which is given to rescuers on where they have to be cautious.

The role of a similar technical team, JKR, has been highlighted in Security Council i.e to provide 'technical and skill services in the field of forensic, geotechnics, structures, and etc. as in landslide or structure failure cases'.

In addition to the aforementioned roles, the landslide response team under the new agency should provide the following assessment

- To determine the type and cause of landslide, effect, and extent of damage, i.e to gain an understanding of the overall situation before providing further advise
- To advise the rescue agencies or local authorities on potential dangers from continuing movement of the landslip, if any
- To advise the local authority on immediate or temporary measures to mitigate further damage

In the event of disaster, i.e under the directive of MKN 20, a crucial decision has to be made if the team is allowed to gain access to the RED ZONE area (see **Figure 9.31**). A similar situation is mentioned in the 'GEO Manual – Section 4: Guidance Notes For Inspecting GE Carrying Out Emergency Duties' that in the event of disaster, the assigned officer to the scene of incident should approach the police to obtain permission to enter the cordoned zone. The guidance notes also mentions that the officer's duties is to ensure safety of the rescuers (see **Figure 9.32**).

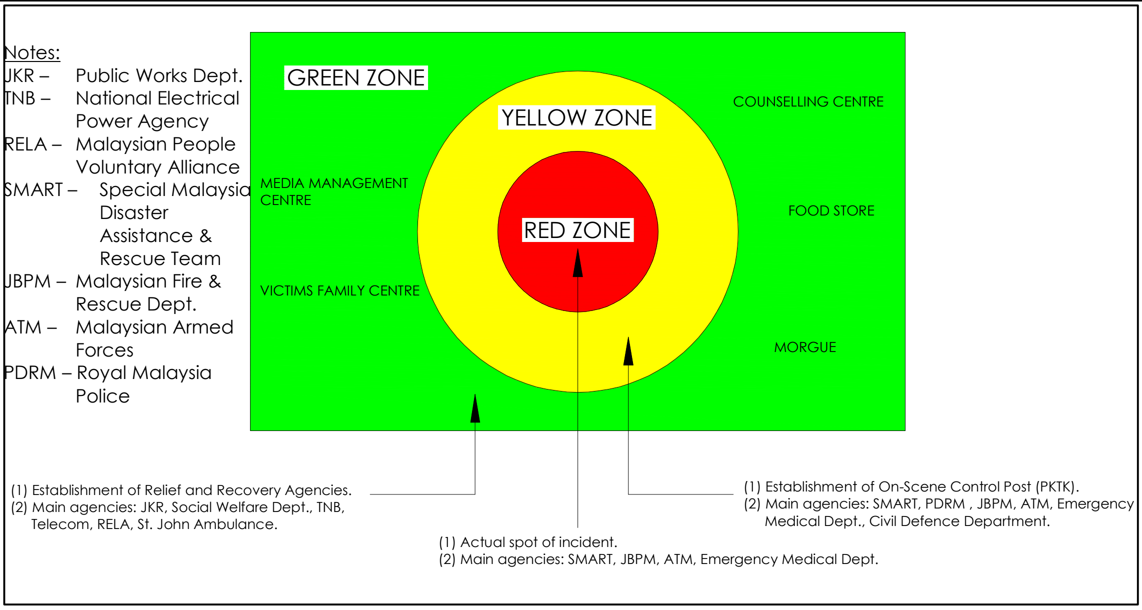


Figure 9.31: Management at Scene of Disaster Based On Zone (MKN 20)

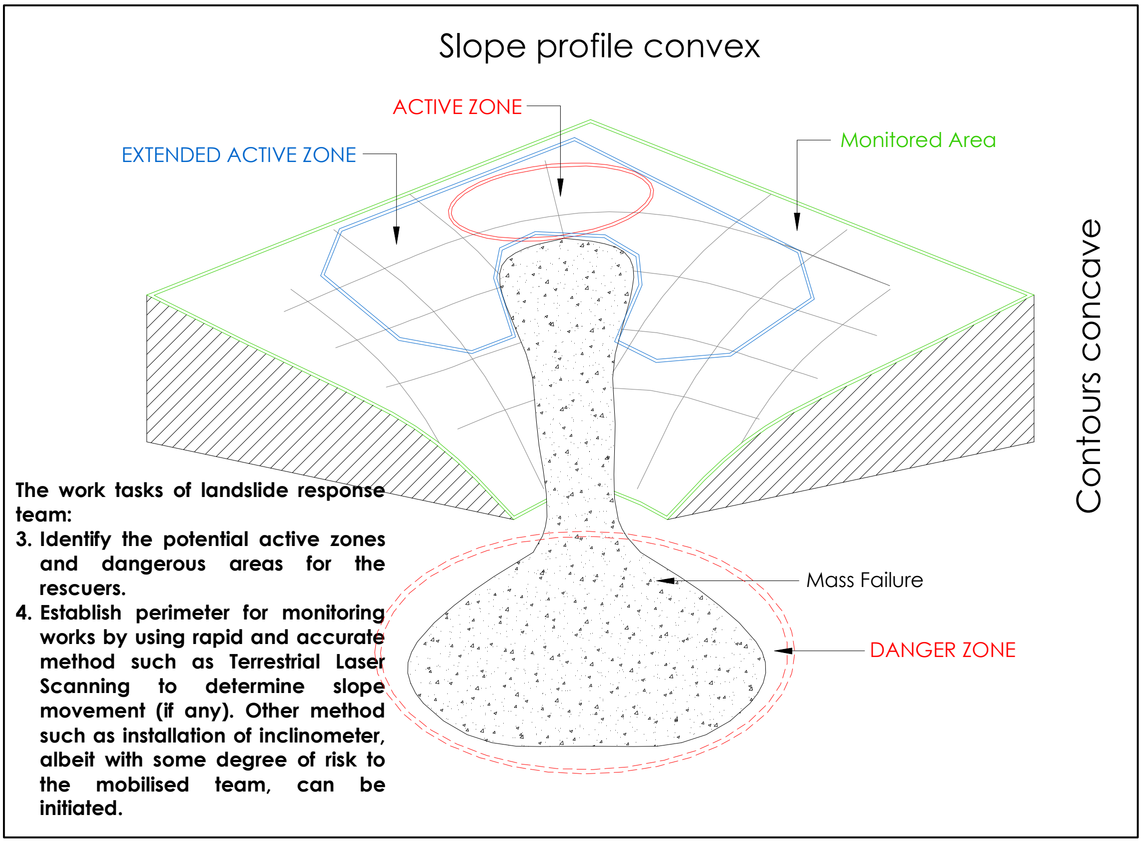


Figure 9.32: An Ideal scenario where advice from landslide response team is crucial to ensure safety of rescuers

Communications

The aspect of communications is vital to ensure that timely and accurate information can be relayed to the rescuers from the landslide response team. As such, may wish to commission the system as the dedicated radio channel for communication between the landslide response team and the various rescue agencies. The aforementioned service is currently provided by a local firm, i.e sapura research sdn bhd.

To ensure effective communication, SEA can consider VSAT communication system which can provide a cost effective means of having a communication link between the ECC and the field in landslide operations in both urban and remote areas. The VSAT system can be programmed to provide communications support for various type of applications such as high speed Internet access, transfer data, private-line voice, and video signal. With VSAT, the mobile unit is operational even in remote areas as communications can be relayed through the Internet.

Methodology for Search and Rescue of Buried Victims

In most cases, the first question to put forward from the rescuers is where to locate the buried victims. At this particular moment, a decision has to be made by the Incident Commander or Emergency Manager to concentrate the search and rescue at the probable buried victim location (see **Figure 9.33**).

In view of the above, the SEA landslide response team can play an important role in sharing their knowledge with the rescuers in locating the buried victims. This is primarily due to the fact that an understanding of the landslide mechanism can leads to a better judgment for pinpointing the location of a buried victim. Each landslide is unique, and therefore, the team member has to use his/her own judgment to maximize the victim's chances of survival within the limitations of available resources.

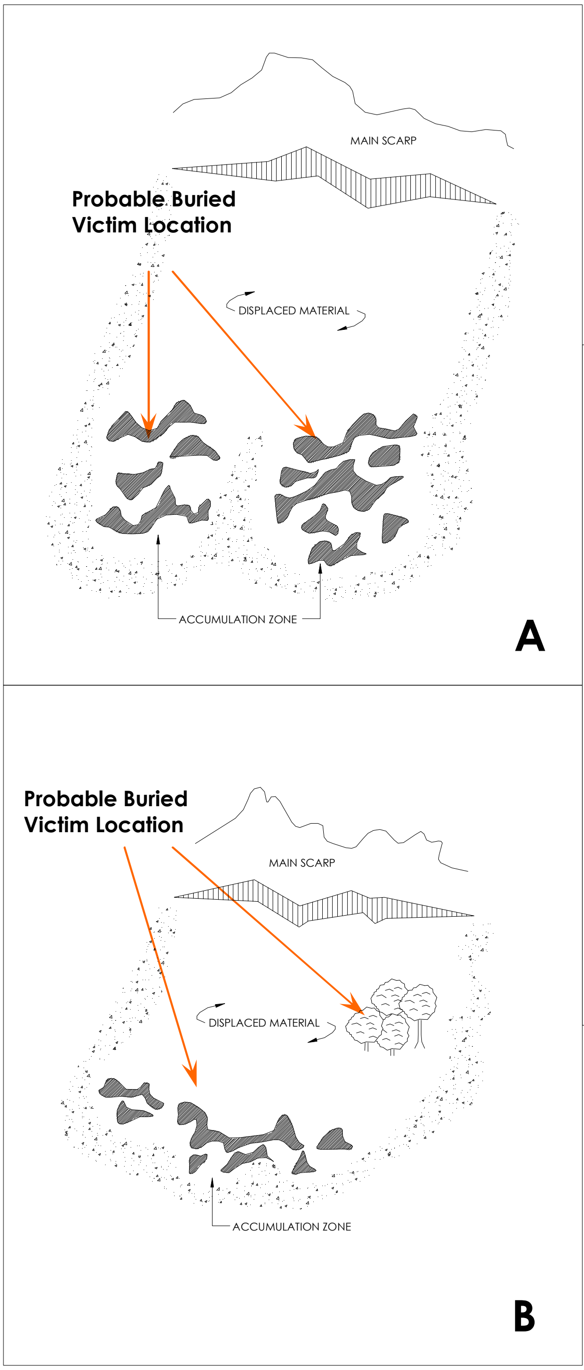
Simple steps can be taken to locate buried victims by using the 'classic' approach:

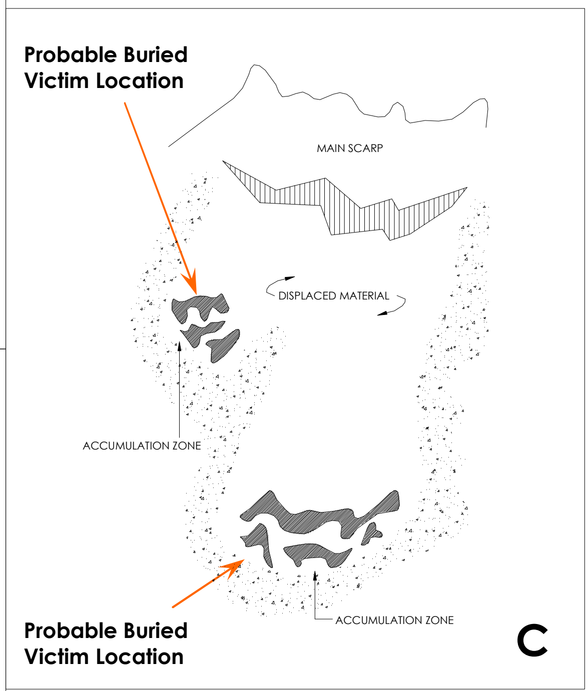
- Interview eyewitness to gain information of the incident.
- Conduct a visual scan of the landslide debris. Look-out for evidence of clothing and vehicle, which may indicate the location of the partially buried victim.
- Marked the location of the object last seen as the search should be concentrated at the burial area, i.e along the down slope trajectory from the marked points last seen. In general, the buried victim of a landslide (mass movement of earth) is usually found at the 'Accumulation Zone' (see **Figure 9.34**). Other areas should not be ignored are the edges of the landslide debris, and obstacles such as trees, which may have 'trap' the buried victims.

File picture dated 16/10/2003 – Federal route (CH 5950m) leading to MEASAT station, Gunung Raya, Pulau Langkawi.

File picture dated 16/10/2003 – Federal route (CH 5950m) leading to MEASAT station, Gunung Raya, Pulau Langkawi.

Figure 9.33: Search and Rescue operation in progress





NOTE:
The designated figures A, B, and C are depicting possible different scenarios associated with the 'shape' or 'outline' of a sliding mass.

Figure 9.34: **Idealised scenario where buried victims can be located (especially at the accumulation zone)**

All of the above actions of the landslide response team can only be effected with the agency having the requisite equipment, the personnel with the necessary skills and all this has to dovetail with regular training.

<u>Exposure to Training</u>

Training is the key issue, both to facilitate the implementation of a Landslide Response programme and to improve communication between various rescue agencies. Without proper implementation of focused training, it is difficult to mobilise the required individuals to act as efficient personnel during disasters or emergencies. Other than the normal training in geotechnical aspects, training for emergency personnel should cover the following areas:

- Landslide safety
- Establishing and maintaining an Emergency Control Centre (ECC)
- Navigation of vehicle on difficult terrain (4 Wheel Drive).
- Basic rock climbing skills (abseiling).
- First aid
- Various types and uses of communication equipment
- Crisis management and proper coordination with the media
- Physical fitness and mental alertness
- Hands-on training from overseas mission

In addition, regular dialogue sessions between the SEA and the various rescue agencies such as Bomba and SMART are vital to foster better understanding and cooperation.

9.3.12 Landslides Investigation in Landslide Recovery Operations

This section highlights the actions or action guideline that should be done during the recovery phase of an emergency under the EPRR division of SEA.

9.3.12.1 Introduction

The need to carry out forensic investigation of landslides by the SEA is an essential task as part of the emergency/disaster recovery phase.

Two renowned institutions, GEO of Hong Kong and the Transportation Research Board (TRB) of the U.S. have highlighted the importance of landslides investigation.

Firstly, the GEO has published a circular (Information Note 9/2006, Sept. 2006) titled 'Landslides Studies by the Geotechnical Engineering Office that attributes the benefits of landslides investigation as the following (see **Figure 9.35**):

- *Identification of slopes in need of early attention under the Landslip Preventive Measures (LPM) Programme and review of earlier studies*
- *Provision of forensic evidence in cases of landslides that may involve coroner's inquest, legal action or financial dispute*
- *Provision of data for reviewing the performance of Government's slope safety system and identifying areas for improvement*
- *Improvement in knowledge on the causes and mechanisms of landslides in Hong Kong so as to formulate new ideas for reducing landslide risk and enhancing the reliability of landslide preventive/remedial works*

Secondly, 'The Special Report 247' by the TRB (1996) titled 'Landslides Investigation and Mitigation' in Chapter 7 stated that '*Investigation should be directed toward both recognition of actual or potential slope movements and identification of the type and causes of the movement'. Both aspects are important in identifying appropriate procedures for the prevention or correction of landslides.'*

In view of the above importance, SEA shall ensure a comprehensive forensic study to be done on landslides leading to a detailed compilation of forensic report.

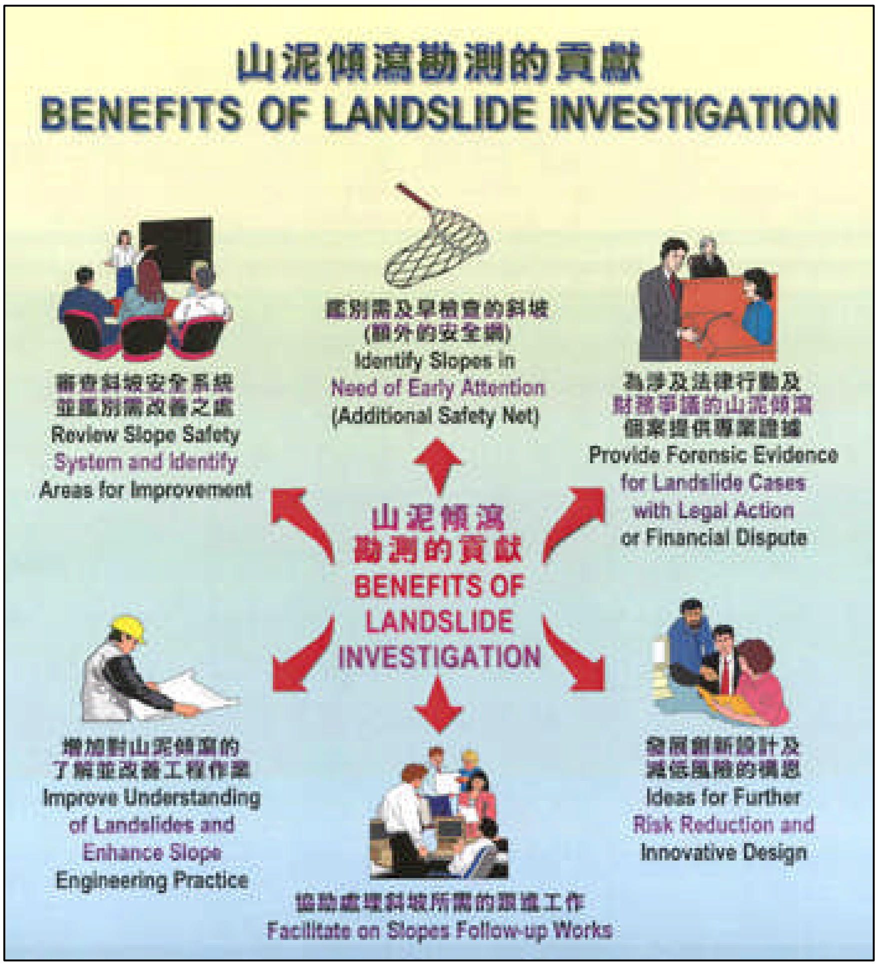


Figure 9.35: Graphical Illustration by GEO Emphasising on the Benefits of Landslide Investigation

9.3.12.2 Main Objectives

The forensic report shall consist of the following primary objectives

- To document the circumstances surrounding the failure event
- To determine or evaluate the likely cause(s) of failure based on documented facts, engineering analyses, and relevant expertise
- To solve the landslide problems or improve on the stability of slopes by prescribing appropriate remedial measures
- To postulate on the possible cause of death of buried victims

- To assist the court in determining the facts of an incident

9.3.12.3 The Scope of Investigation

The critical elements involved in the scope of forensic investigation are briefly described in **Figure 9.36**. The figure shows that forensic investigation generally covers several important aspects such as the following:

- Formulation of the investigation (a clear definition of the purpose of the investigation)
- Data collection
- Data interpretation
- Application of analysis techniques
- Communication of results

The execution of a proper subsurface investigation (SI) is critical during the forensic investigation. The importance of SI is attributed to the following reasoning: the validity of the test results and analyses is based entirely on the quality and extent of the field investigation on which the analyses rely upon for accurate computation. Without the existence of quality SI data, the engineer has no choice but to impose over refinement to the analysis, which the outcome will not lead to the improvement of a design or a cost effective one. The typical framework for the planning of SI is shown in **Figure 9.37**.

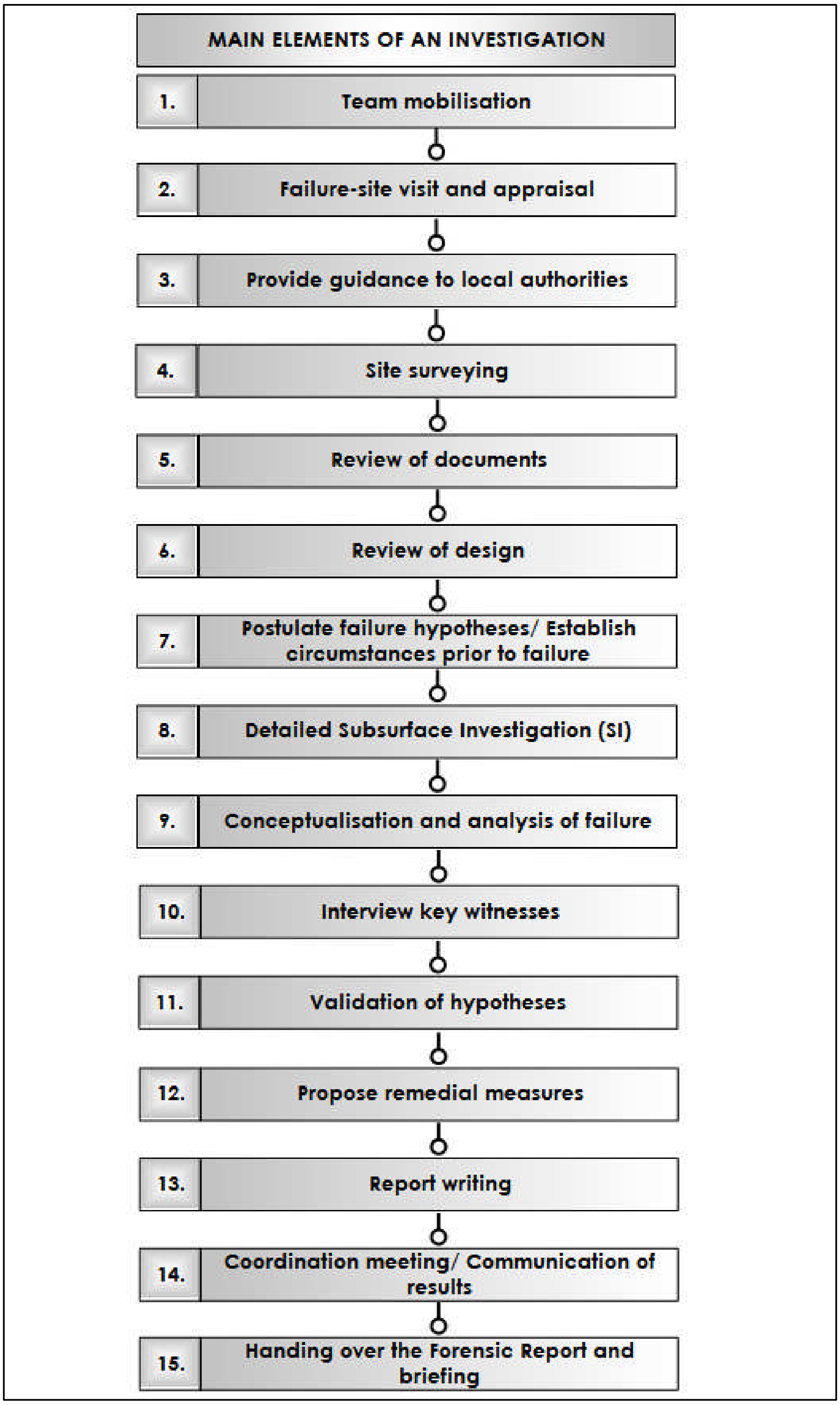


Figure 9.36: Main elements of forensic investigation

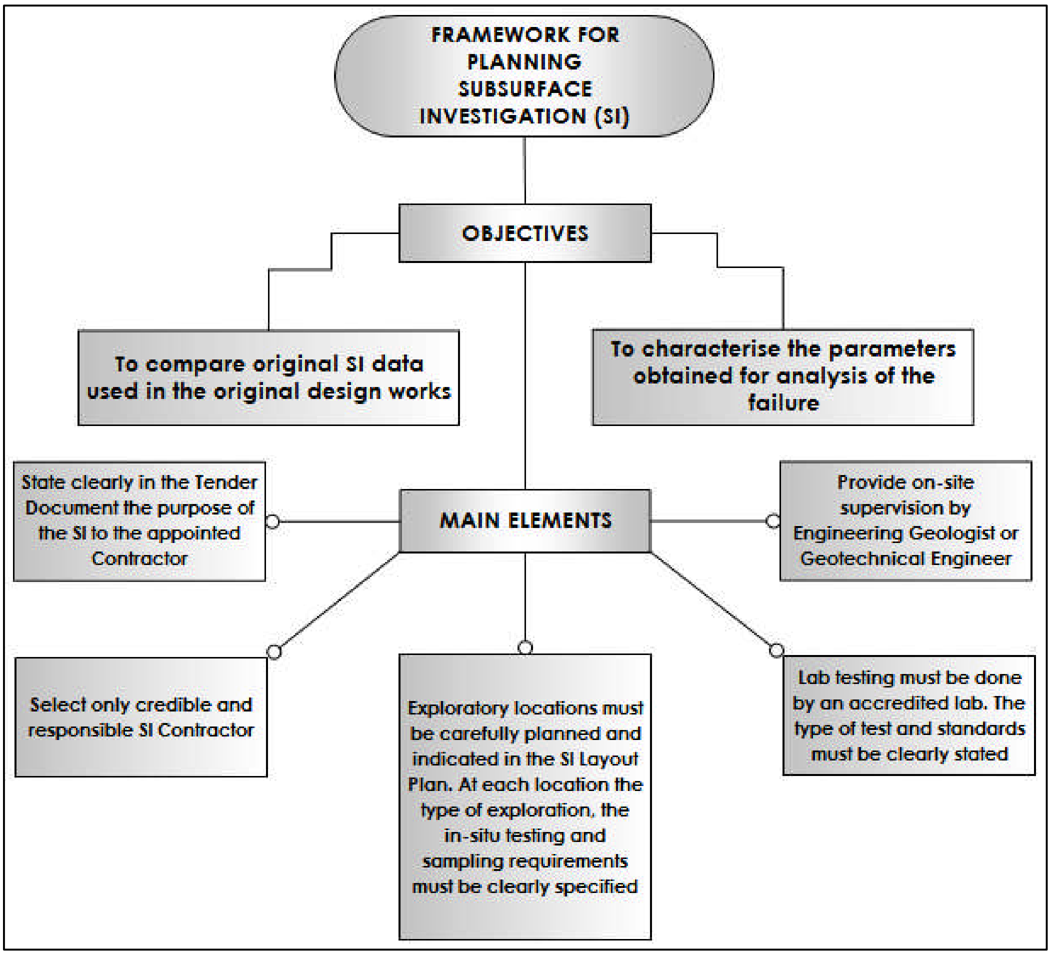


Figure 9.37: **Framework for SI Planning**

9.3.12.4 The Scope of Report

The type of forensic report shall be divided into the following:

- Inspection Report
- Forensic Report

The inspection report can be generated in a relatively short period of time (one to two days), to provide a general assessment of the failure site situation. This report will promptly identify the issues pertaining to the landslide investigation, and subsequently, to focus on the relevant issues effectively.

The structure of the forensic report should cover the following key elements:

- The subsurface investigation (SI)
- The conceptualisation and analysis of failure
- The records of interview of key witnesses

The forensic report can be further divided into two stages:

1. Preliminary investigation (duration of about two weeks to one month): the primary objective is to determine whether the structure affected by the landslide is safe for occupation or areas of the surrounding landslide is safe in the short term
2. Detailed investigation (duration of about three months): the primary objective is to determine the cause of the landslide, i.e. on 'why and how' it happened.

It is imperative that the report must be factual and supported by evidence as the findings in the report may be submitted to court or arbitration. Also, the report must be coherent to ensure there is no contradiction between statements in the various chapters, which may happen due to report writing of different authors.

9.3.12.5 Resources

The required manpower to conduct landslides investigation can be sourced from the relevant personnel within the department. However, if in-house or internal resources are inadequate or unavailable, the department may consider seeking external assistance from established consultants.

The formation of the external investigation team (if required) should possess the following characteristics:

- Formed as a standing panel; ready to mobilise on call basis.
- Panel to be inter-agency and multi-disciplinary
- Panel needs to have clearly defined written objectives, common values, roles, responsibilities, authority, and functions
- The team leader and the secretariat need to be identified
- Panel members should be qualified, experienced, and competent
- Means and line of communication for panel members must be clearly defined.

9.3.12.6 Key Proposals

The report of the forensic investigation should be published and made available to the geotechnical profession or relevant governmental agencies. SEA may wish to keep the forensic reports in a library or resource centre, where the reports can be assessed by the general public or restricted to the geotechnical profession. The importance of sharing knowledge through the dissemination of information is shown in **Figure 9.38**.

The process of releasing forensic investigation reports to the general public has been a common practice by the GEO, albeit to a lesser extent whereby only selected study reports are reprinted as GEO Reports. The reports are available at the Civil Engineering and Development Department (CEDD) of Hong Kong website and also for sale through the Government Publications Centre.

Lastly, SEA should strive to produce a standard manual on forensic investigation that will guide the practitioner through the various stages of the investigation such as data collection, site characterisation, interpretation of data and analysis, development of failure hypotheses, reliability checks, and legal issues. The abovementioned key proposals are illustrated in **Figure 9.39**.

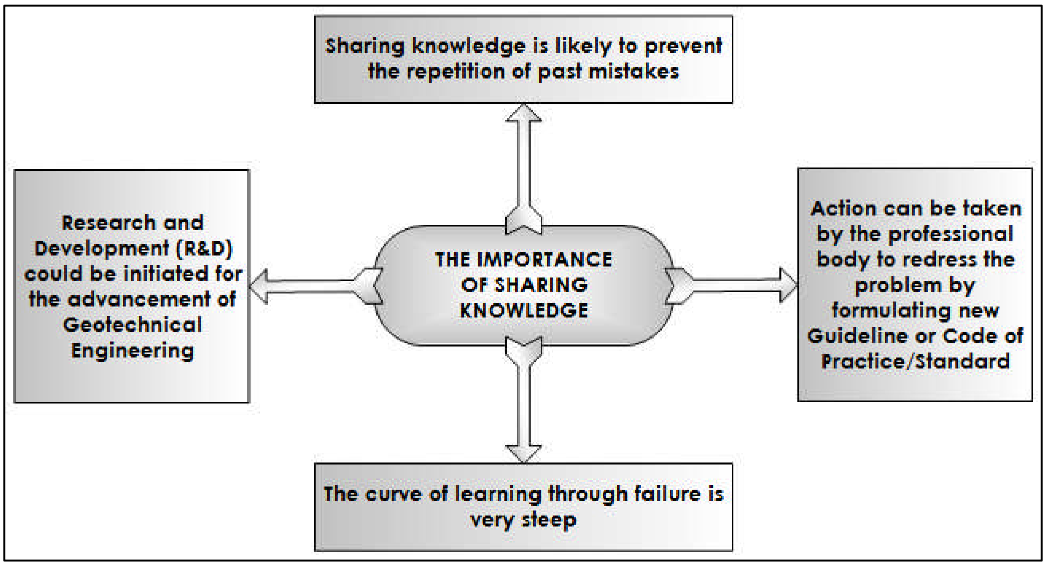


Figure 9.38: The importance of sharing knowledge

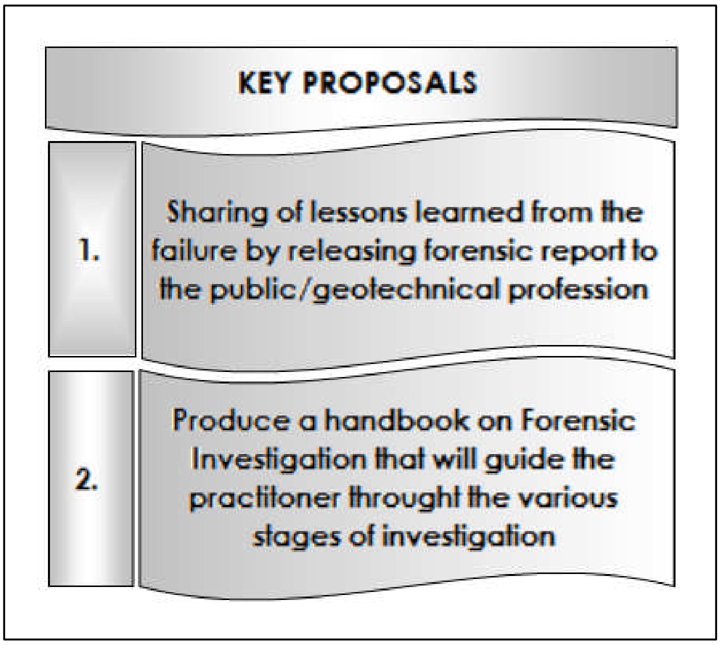


Figure 9.39: Key proposals for forensic investigation

9.3.12.7 Preliminary Cost Data

The projected or estimated cost for the forensic investigation is presented in **Table 9.13**. The cost is estimated for the whole duration of 15 years. The estimate is assuming a site investigation cost of RM400,000.00 and a printing cost of RM50,000.00 for a major landslide.

Table 9.13 Summary of Preliminary Costing for Forensic Investigation

Implementation Stage	Period (year)	Assumptions Made	Cost (RM 000,000)		Total (RM)
			Investigation	Report	
Phase 1	2009 - 2023	4 major landslides per year	24.0	3.0	5,964,000

Note:

* – Comprising of subsurface investigation (SI), geological mapping, airborne LiDAR, ground survey, and aerial photograph.

9.3.13 The Road Map Ahead

Having surveyed the present setup of the emergency response situation in the country and studied the manner in which emergency response is handled in various nations, an approach can be proposed for setting up a Landslide Emergency Preparedness Response Recovery section in the new agency that will manage all matters pertaining to slopes, which is SEA. Other than making some key proposals certain guidelines will be presented that will give shape to the Emergency Preparedness Response Recovery office.

The EPRR Shape

The time and effort incurred in the preparation and planning work to deal with emergencies is always a good investment: as preparation and planning will minimise landslide damage both in physical and in human terms.

The steps taken to manage the adverse effects of any landslide incident form the substance of EPRR management. These steps include the preparation, the planning, and the training of personnel in realistic landslide scenarios in addition to the purchase and stationing of equipment. This to be in concert with the setting up of the necessary organization. Its staffing includes the establishment of operational procedures and standards, with all of these to be in lock step within a legal framework that facilitates rather than inhibits the smooth running of the proposed landslide EPRR management office.

Thus, the landslide EPRR management setup that is to be established to handle landslide disasters will have to draw up a set of guidelines for all emergency involved personnel:

from guidelines for the EPRR Head or emergency manager and down the line for all of the members in the various branches and units. This needs to be written down and distributed to all personnel involved in landslide emergency management. This is of prime importance in emergency management as the fast moving disaster environment and the stress it creates does not give time to involved personnel to dither over whose job it is and who to contact for needed services or authorisation. All these must be made clear so that all know what are their particular tasks.

Well - structured guidelines actually improve the response of the EPRR section of the SEA office, as well as protect its operational efficiency in terms of manpower deployment and usage. To come up with well - thought out guidelines, certain basic issues involving its organizational setup – principally to identify what needs to be included in their office setup, which is dependent on the assign role and scope of the EPRR landslide management office - needs to be addressed first. Once that is done, it will help provide us with the basis for drawing up a set of guidelines and checklists for its office personnel from the EPRR manager and to other of his team members.

The first step in drawing up a well - structured set of guidelines is to determine the core issues in an emergency management situation. These core or basic issues must be addressed in any form of emergency management organisation, be it a landslide emergency response agency or a flood emergency response type organization. In short, these core issues under gird all the guidelines: in other words, the core issues addressed here is also the EPRR emergency management guidelines itself; at least it forms a fair and salient portion of them.

<u>The Core Issues</u>

Whatever the scope, all emergency preparation response recovery management must address the following core issues:

<u>Assign responsibility for managing a crisis</u>

- Identification of threats
- Drawing up of mitigation measures against identified threats
- Prepare the emergency plan

- Practice the emergency plan

Assign responsibility for managing a landslide crisis

- Nominate a person to action these five steps and draw up a comprehensive emergency response management plan
- Set up an emergency response management team – the people who are actually responsible for responding to and managing an emergency
- During an emergency the leader and the team members must make hard decisions under stressful conditions. They must be given the necessary authority to do so without undue reference to a higher authority.
- Alternates must be appointed since some staff might be away or not available during an emergency. Alternates are needed during a prolonged emergency as staff needs to be rotated.

Identification of possible landslide threats

- Consider the most probable type of landslip incidents that will occur and where i.e. identify landslide prone areas
- Identify probable logistic problems that could arise because of route accessibility
- Identify the vulnerability of the threat especially if the high - risk prone area is situated in a densely populated region

Mitigation measures to overcome landslide threats

- Take whatever mitigation measures that can be done in high risk landslide areas. Since mitigation measures can involve different administrative entities, i.e, different districts and states, and both private and public land holdings: the necessary framework to handle this will have to be studied and solutions found. This is necessary as mitigation measures can and will involve some form of financial outlays.
- Undertake to increase capacities for vulnerability reduction through risk identification such as linking hazard mitigation with land use planning.

Prepare an emergency response plan

- Ready a plan of action to take on a declaration of a landslide emergency; for instance quick dispatch of geotechnical engineers and equipment.

Practice the Plan

- Consistent and regular drilling on the plan with real life scenarios is essential for the plan to work. There is no alternative to this if the plan is to work, as it is designed to, when an emergency happens.

The EPRR Organization Framework

The organisational framework of the EPRR will be based on assumptions which in itself are based on the best practices and setup in other countries, but taking into accounts our own requirements and environment. It is envisaged that the EPRR setup will be as depicted in the functional organsation chart as shown below in **Figure 9.40**. The EPRR set up main aim is to provide on-site assistance or technical advice to the various rescue agencies during an emergency as well as after it.

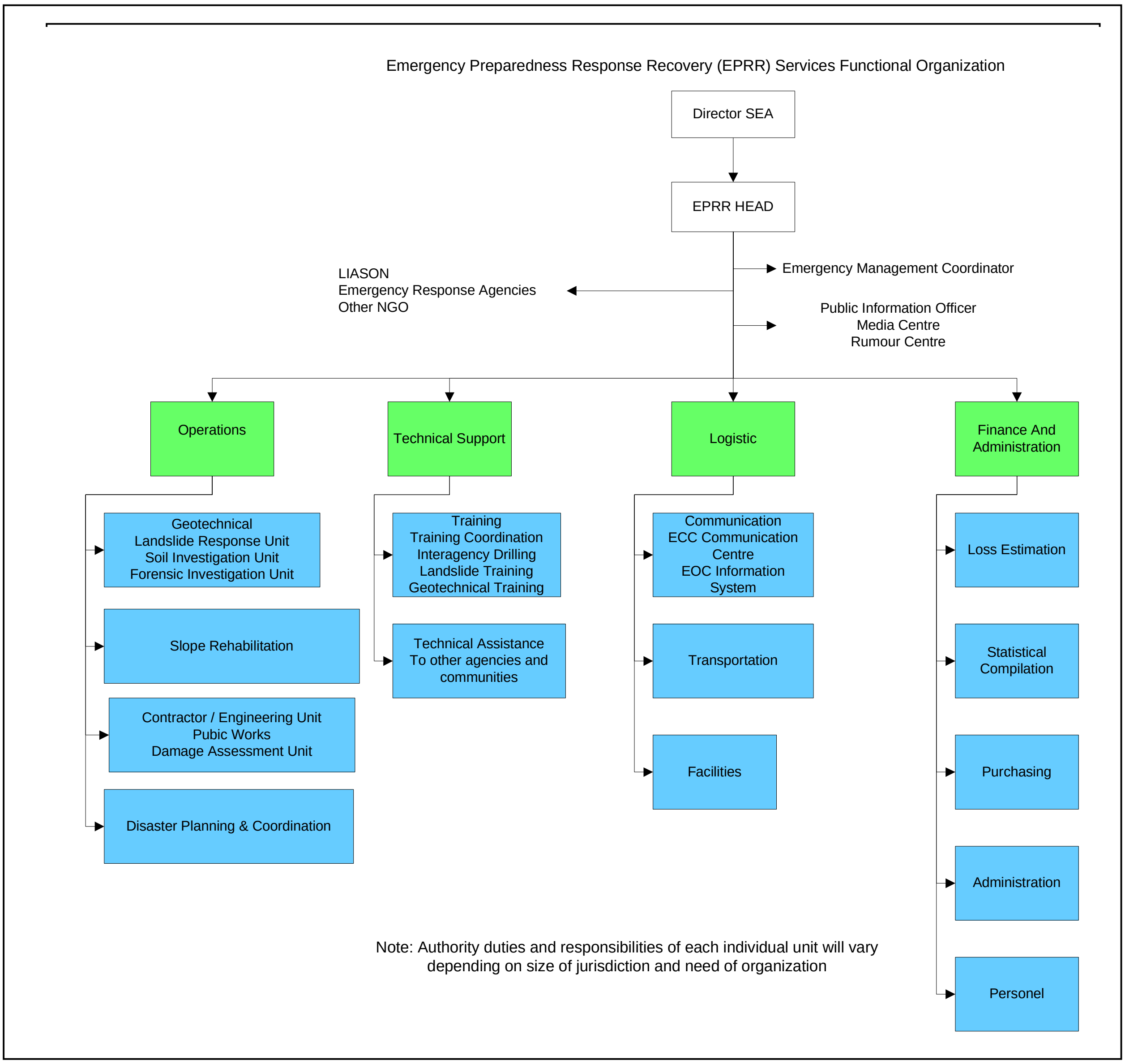


Figure 9.40: EPRR services functional organisation chart

The functional organisation framework as depicted above is self explanatory; it depicts the work that is planned to be carried out. As an example under Operations, there are various branches such as geotechnical under which the following functional units such as Landslide Response, Soil Investigation. Forensic operates. Staff in these units have a commonality of expertise (staff in these units are mainly geotechnical engineers, geologists, geophysicists, and geographic information specialists) and can be deployed to each other operational units if the need arises. The tasks or specifications of these staff are not intended to reflect all duties performed within the job; as duties, responsibilities and authority will vary depending on the needs of the organisation. And flexibility is a hallmark of any lean, efficient organization.

<u>The Guiding Principle</u>

The guiding principle in drawing up the EPRR functional organisation is that any guidelines drawn up will be bending towards making the EPRR head and his team work and role an effective one in providing onsite assistance or technical advice in an emergency landslide response situation.

<u>Some Guidelines</u>

- The EPRR will work closely with all emergency response managers from all other emergency response agencies such as Bomba, SMART, Police, JPA3, Public Works, the emergency medical services and other volunteer services.
- The EPRR will initiate training exercises on a regular basis, to ensure that the landside response unit responds as planned when it is executed in an emergency.
- The EPRR head as part of the SEA office will help put in place mitigation, preparedness, response, and recovery programs to deal with landslide management. This work is very important as it preempts landslide incidents from happening and if it does occur, such measures reduce its severity. The cost outlay can be high and the extent to which such measures will be adopted will depend on the acceptance by the authorities that this planned approach is the better way in dealing with landslide occurrences. In short, monies spend on preparedness will reduce the expenditure on response and recovery over time while reducing the severity and number of landslide incidents.
- The EPRR head should contribute to policy decisions regarding comprehensive disaster risk management programs as the EPRR division is a key participant in landslide management.
- The EPRR component should help contribute to the revision and implementation of legislative reforms in disaster risk management as EPRR is in the thick of all landslide management programs.
- The authority given must be written and in as much detail as possible. It must be clear on the job scope of the EPRR in emergency response situations and for each of the staff under him, with clear unambiguous lines of reporting and specific on

what is required of each and every staff in an emergency situation. In other words, operational procedures and standards must be set up in detail and in writing, and be made known to all involved staff.

- The organisational structure of the EPRR emergency and communication centre setup that is called into being in the event of an emergency must be clearly defined and made known. The ECC should ideally be linked to control centres of other emergency response agencies; this can be initiated through a mutual cooperation agreement among agencies. The office can be a virtual office in a non - emergency situation but will be physical one on activation. In addition EPRR will look into and acquire mobile control centres, to be based on site in landslide emergencies to communicate and to facilitate transmission of data.
- Any emergency management guidelines must be configured to operate within the incident command system (ICS). This is a necessary requirement as all emergency response agencies utilized the ICS at its most basic emergency response level, i.e, the field response level. In fact the functions, principals, and components of the ICS at the field response level are highly applicable in any level of emergency response; this is the beauty of the ICS.
- All guidelines must, as far as possible be operationally viable, within the boundaries set up in the MKN 20 legislation. This is to ensure that operations of the EPRR landslide emergency management office will be in compliance with legislation.
- The guidelines must include compulsory and periodic carrying out of realistic landslide disaster scenarios. There is no other way, other than real life drilling scenarios, to ensure that what is planned comes to pass.
- Knowledge of where to source equipment, and how to deploy them in an emergency forms part of the guidelines.

It needs be emphasized that these guidelines should be drawn up with the establishment of the SEA. And then an SOP for landslide can be drawn up in consultation with other emergency response agencies, under the guidance and authority of MKN. Only an SOP based on the real capabilities of all the various stakeholders together with inter-agency drilling will give the authorities a smooth response by all stakeholders to a landslide emergency. It is important to remember an emergency always overwhelms the capability of a single emergency response agency; so it is the smooth combined response of all agencies working in concert that actually defines effective response. A well - crafted SOP based on actual capabilities of all stakeholders will help greatly here.

Key Proposals

From the various technical visits, studies of the local emergency response situations and needs we have arrived at a series of key proposals which needs be implemented to enable the country to have an effective and responsible landslide emergency response agency.

- Set up the SEA with clearly defined roles and functions and empowerment to issue landslide warnings and advise.
- SEA to be recognized as the "Authority' in all landslide matters. This means it is.
    - The authority to issue advice on potential dangers to landslide incidents to all government bodies and the public
    - The authority to which the public will go to solicit advice on all matters pertaining to landslide
    - The authority to tabulate all landslide incidents, collate and analyse loss estimates
- SEA to establish regional officers so that geotechnical specialists will be on - site in a defined time to make crucial decisions required by emergency response stakeholders.
- SEA to set up ECC with communications network able to keep track of and inform all response agencies of unfolding events.
- SEA to purchase all necessary equipments and provide training to personnel to become emergency geotechnical engineers.
- SEA to initiate inter-agency discussions under a mutual cooperation agreement to come up with an integrated, common approach, comprehensive and relevant landslide SOP based on actual operational capabilities and procedures of all emergency response stakeholders. This will ensure the full committed compliance of all stakeholders.

- SEA will initiate inter-agency discussions and commitment to have inter-agency drills to have a smooth emergency response to landslides.

9.4 Recommended Strategies

9.4.1 Introduction

In order to achieve the aims of the of the NSMP it is necessary to find ways to deploy available resources to obtain those aims; in other words to formulate strategies to achieve those ends. Strategy is use to bridge the gap between aims and means.

9.4.2 Strategic Thrust

The strategic thrust clls for a nationwide structured action plan to deal with landslides when they do happen. Its main aim is to focus on any landslide incident where there is danger to lives and property which calls for immediate actionthat may or may not exceed the capacity of normal resources and operations of organizations.

The drag and weight in emergency response and recovery situations can be overcome by establishing and adhering to clear, well - defined guidelines and procedures backed by sufficient equipment and a team of highly motivated trained personnel held together through a regime of continuous drilling exercises operating within a strong framework.

The strategies and accompanying action plans will not only ensure that the nation will be well prepared to face landslide emergencies but also ensure that the authorities could provide a quick and effective response and adopt recovery measures to contain damage.

Table 9.14: Strategic Thrusts

Strategic Thrust	Strategies
Improve the ability to prepare, respond and recover from landslide emergencies, thus reducing losses of lives and to the economy	9.1 Develop capacity for quality emergency response and recovery 9.2 Provide necessary support, advice and forensic reports in landslide emergencies

9.4.3 Strategies

Strategy 9.1	Develop capacity for quality emergency response and recovery.

Good emergency coordination always translates into good response. This is the main reason to have a formal and well-synchronised inter-agency coordination to ensure that national, state and local authorities and other stakeholders undertake coordinated and integrated landslide disaster management planning and action, which are in alignment with MKN 20.

The following activities would be carried out under this strategy:

Action Plan 9.1.1

Define and put in place clear policies, mechanism and procedures.

In a landslide emergency it is crucial that response be on site within the hour after notification if lives or property in danger are to be saved. This requires emergency response deployment of all stakeholders to be on time to give effective response to meet this threat to lives and property. To ensure that this comes to pass, clear policies and procedures must be well laid out, must be well - coordinated and followed by all as there is no time in an emergency to dither or to debate over who is to do what and how to do them.

In Malaysia, nationwide policies and mechanisms for landslides have to be documented in a Standard Operating Procedure (SOP) to be jointly prepared by all agencies involved in landslide disasters. A good example of a national SOP is the one prepared for flood disaster. The preparation of such SOP, which normally takes about two years to complete, should be coordinated by SEA. This landslide SOP will then have to be submitted to the MKN for approval and distribution.

Among the policies that should be considered are

- SEA should form part of Government Integrated Radio Network (GIRN) – In order to ensure proper communication during landslide disasters, SEA should also be considered to be one of the government agencies with GIRN facilities.

- SEA should be part of the national emergency communication system – TM, which mans emergency communication should also inform SEA along with other relevant emergency response agencies, when a landslide is reported via "999" so that SEA could respond within the stipulated time.

Other than SOPs for landslide at the national level, a more detailed SOP at the SEA's departmental level will also need to be prepared. This SOP will cover not only the detailed procedures that need to be adhered to by SEA during landslide disasters, but also during all stages of landslide emergencies. This departmental SOP should be cross - referenced to the nationwide SOP and will need to be submitted to MKN for approval, as required under MKN 20.

All national, state and local agencies identified as key role players in landslide disaster management are required to prepare their own SOPs which cover landslide disasters. However, it should be recognised that there is considerable unevenness in landslide disaster management planning capacity and experience, and the need to undertake careful consultation with relevant stakeholders before developing these SOPs.

To achieve integration across all levels, SEA must be given the task to guide the development of SOPs on landslides to ensure coherence and uniformity, and align these to MKN 20 and the nationwide landslide SOP. It must also consult with the ICSM.

Action Plan 9.1.2

Purchase suitable equipment and situate them near landslideprone areas

For timely response to landslide emergencies, stakeholders should purchase suitable equipment such as search equipment and heavy machineries in sufficient numbers and situate them based on hazard or risk maps that are disseminated by SEA. As for SEA, equipment that enable its geotechnical engineers to determine the extent, speed and direction of the landslide must be purchadsed.

Examples are these equipment are :

- Three Dimensional Terrestrial Laser Scanner
- Ground Penetrating Radar

- Robotic Total Station
- AirRobot – Radio controlled helicopter for aerial reconnaissance

These equipment and trained technicians are to be situated at the regional centres, which will be set up in or near high-risk landslide areas, to ensure that these equipment and personnel can reach the landslide site on time; and in concert with the geotechnical engineers. It is also crucial to ensure that these equipment are in operational readiness at all times.

Action Plan 9.1.3

Set up an emergency control centre with communication networks.

The Emergency Control Centre (ECC) is a centre where during a declared emergency, all landslide incidents will be monitored enabling the SEA emergency team to keep track of the fast unfolding landslide disaster and inform all emergency response agencies of the unfolding events.

At least one such centre shall be set up at SEA headquarters. It will be responsible for monitoring and handling documents and reporting the landslide information such as the size, severity, number of casualties, search and rescue operations and damage to public and private property including roads. This flow of accurate information during a landslide incident will enable informed decisions to be made on how best to resolve the incident and ensure factual reporting of the situation to all authorities and via the media to the public.

In order to connect to being part of GIRN and the Internet, a satellite antenna at the control centre and a Very Small Aperture Terminal (VSAT) which could be mobilised immediately to the landslide site, is proposed to be included.

Action Plan 9.1.4

Conduct inter-agency drills among various emergency response agencies

Inter-agency drills incorporating real-life scenarios are very necessary to raise the level of response in emergencies. This has been proven to be the case in various countries.

Almost all emergency response agencies in Malaysia have also highlighted the need for regular inter-agency drills. Only periodic drills can reveal the flaws and the inadequacies in a coordinated response and recovery, so that policies or mechanisms could be further improved without having to learn from an actual landslide emergency.

ICSM could be used as the vehicle to formulate a mutual cooperation agreement between various stakeholders in landslide emergency. With assistance from other agencies and the directive and approval from MKN, SEA could conduct mutual inter-agency drills on landslides.

Strategy 9.2	**Provide necessary support, advice and forensic reports in landslide emergencies**

Once a landslide emergency happens, the various emergency agencies initiate a response and recovery effort. These agencies each deal with various aspects of a landslide incident from search and rescue to dispensing medical relief, providing food and shelter, conducting evacuation, offering geotechnical advice, maintaining communications, controlling crowd and traffic and handling the media.

Each emergency response agency has each its own operational plans and guidelines to guide its efforts. There is an arrangement under MKN 20 for an incident commander to manage all disasters including landslides. However, SEA can be tasked with the primary responsibility of providing geotechnical expertise with the other technical stakeholders assuming secondary responsibilities.

Better coordination always translates into better response. This is the main reason to have formal close inter - agency coordination to ensure that national, state and local authorities and other stakeholders undertake coordinated and integrated landslide disaster management planning and action, which are in alignment with the National Directive No. 20.

Action Plan 9.2.1

Provide adequate and immediate support to emergency stakeholders in the aftermath of landslides

Support through information management and technical assistance at the scene of a disaster will enhance the search and rescue operations, thus saving lives. The issue of safety during the search and rescue operation is crucial as lives of rescuers can be jeopardised. In order to minimise the risks of exposing the rescuers to dangerous situations, SEA shall look forward to mobilising an emergency landslide response team to provide onsite assistance or technical advice to the various rescue agencies.

In most cases, the first question of the rescuers is the location of the buried victims. A landslide response team can play an important role by sharing their knowledge with the rescuers in locating the buried victims. This is primarily due to the fact that an understanding of the landslide mechanism can lead to a better judgement for pinpointing the location of a buried victim. Each landslide is unique and therefore, the team member has to use his/her own judgment to maximise the victim's chances of survival within the limitations of available resources.

Other than providing support to search and rescue agencies locally, the SEA emergency response team should also be deployed to assist in landslide disasters overseas so that useful experience could be gained from abroad.

Action Plan 9.2.2

Provide advisory and forensic services and help bring the affected infrastructure near normal operating condition

An immediate priority after a landslide is to bring the basic infrastructure a near normal operating condition and deal with the hazardous conditions that may exist in the aftermath of the landslide. SEA would work in close coordination with relevant government departments such as local authorities and highway authorities in giving clearance for re-opening of roads; in giving the all clear signal to re-occupy buildings, assist in remedial slope works if required; and providing forensic investigations.

Forensic investigation on landslide is crucial in the recovery and preparedness phases. The report from forensic investigation should be published and be made available to the geotechnical profession and relevant parties involved in the landslide. This report could then be used in decision making and also in court proceedings. It is important to share lessons learned from the landslide to prevent the repetition of past mistakes to initiate R&D efforts and to redress the problems by formulating new policies or mechanisms, if necessary.

9.4.4 Summary

The strategies for EPR are designed to maximise resources such as equipment personnel and guidelines the country can achieve its aim of having a nationwide structured plan for emergency response to landslides in a systematic manner and enable the authorities to engage in effective landslide management (see **Table 9.15**).

Table 9.15: Action plans

Strategy	Action Plans
Strategy 9.1 Develop capacity for quality emergency response and recovery.	Action Plan 9.1.1 Define and put in place clear policies, mechanism and procedures • Establish procedures for SEA personnel to be at site within one hour • Ensure that equipment and transport is 24/7 in a state of operational readiness Action Plan 9.1.2 Purchase suitable equipment and locate them near landslideprone areas • Purchase suitable equipment in sufficient quantities • Provide ongoing equipment training Action Plan 9.1.3 Set up an emergency control centre with communication networks • Establish the ECC with the designated communication equipment and systems • Have trained personnel Action Plan 9.1.4 Conduct inter-agency drills among various emergency

Strategy	Action Plans
	response agencies • Establish a mutual inter-agency drilling agreement between various stakeholders.
Strategy 9.2 Provide necessary support, advice and forensic reports in landslide emergencies	Action Plan 9.2.1 Provide adequate and immediate support to emergency stakeholders in the aftermath of landslides • Provide SAR teams with geotechnical data on slope safety and structural safety Action Plan 9.2.2 Provide advisory and forensic services and help to bring the affected infrastructure near normal operating conditions • Conduct and provide forensic investigation studies

9.5 Implementation Framework and Plan

9.5.1 Introduction

In order to achieve the aims of what is envisaged for the EPRR component of the NSMP. It is necessary to implement the strategies, measures and actions as they are a requirements for success. The following outlines the workflow Of the unplementation process.

9.5.2 Implementation Process (see Figure 9.41)

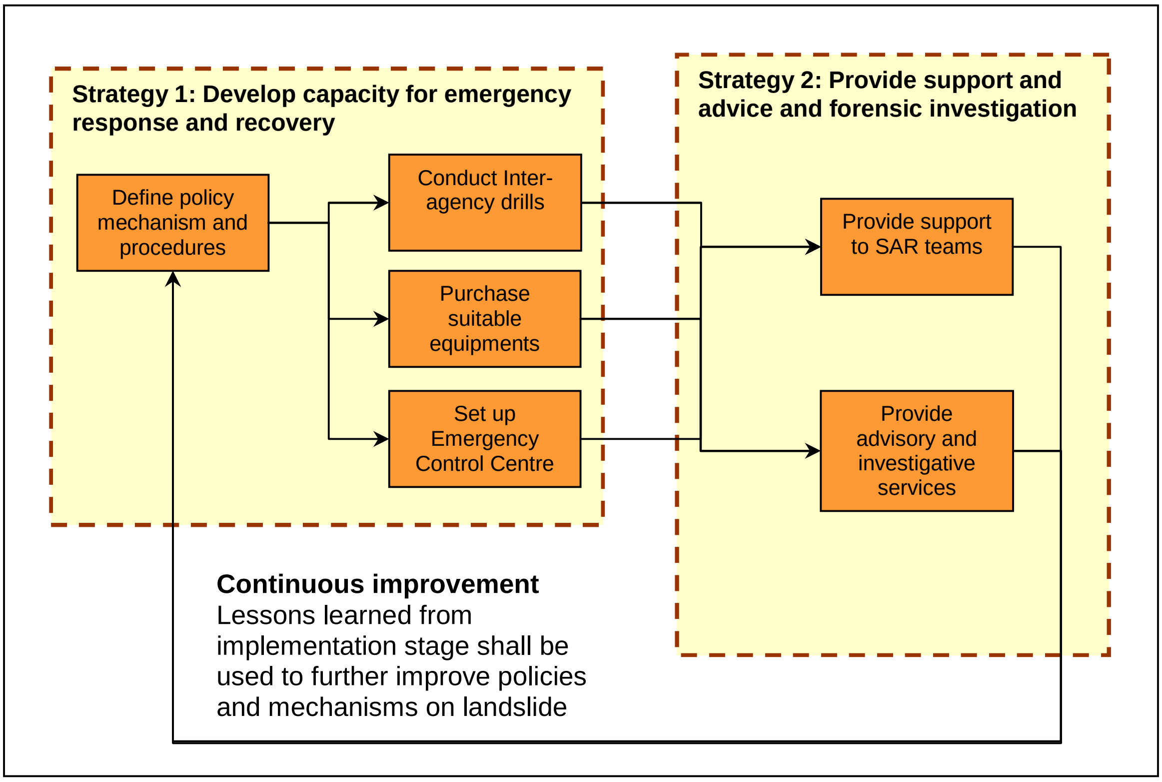
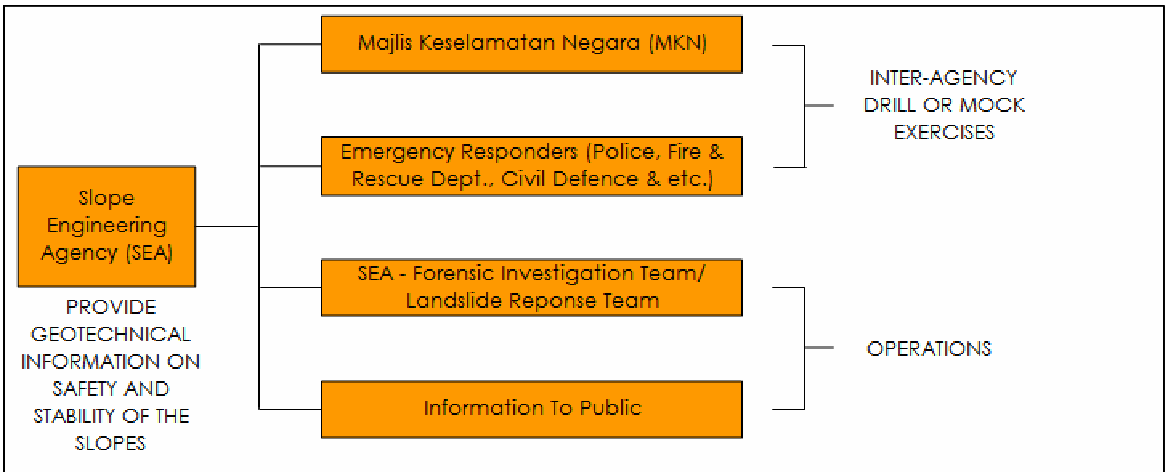


Figure 9:41 Flowchart for implementation process

9.5.3 Implementation Structure (see Figure 9.42)



Implementation of the National Slope Master Plan (NSMP) will required input and coordination from various agencies as depicted in the '**Implementation Structure**' above. This will require good mutual cooperation between the various agencies. EPRR will ensure quick response and establish a forensic investigation team to establish the causes of landslide failures. SEA will in being the authority in landslide matters ensure media savvy public communications is carried out to let the public know that they can confidently come to SEA for and any matters relating to landslides.

Figure 9.42: Implementation structure

9.5.4 Strategy Implementation Framework

The strategy implementation framework indicates that the strategies will be implemented as an ongoing process, with changes made as and when necessary. (see **Table 9.16**).

Table 9.16: Strategy Implementation Framework

2009	2010	2011	2012	2013	2014	2025	2016	2017	2018	2019	2020	2021	2022
Phase 1				Phase 2					Phase 3				
9.1 The strategy for developing capacity for quality emergency response and recovery *is ongoing in all three phases*													
9.2 The strategy for providing necessary support, advice and forensic reports in landslide emergencies *is ongoing in all three phases*													

9.5.5 Implementation of Action Plan

Success in the implementation of the Action Plan depends largly on the effective execution of the various actions with their respective guidelines and clear lines of accountability. Revision of actions should be carried out periodically as and when necessary to ensure their relevance. In terms of inter-agency coordination, it will be useful for the various stakeholders in landslides management and slope engineering to have a formal mutual encourage agreement with MKN as the coordinating and liaison body to more formal cooperation especially in the areas of knowledge and data sharing and in inter-agency drilling.

In general most of the action plans are scheduled phased to be implemented in first half of Phase 1 i.e from 2009 to 2010; upon the establishment of SEA . Thereafter, most will be an ongoing affair. Cost outlay will vary because of organic growth and inflation (see **Table 9.17**).

Table 9.17: Action Plan Implementation

No.	Action Plan	Who	When/Cost (RM Millions)			
			Phase 1		Phase 2	Phase 3
			(2009 – 2010)	(2011 – 2013	(2014 – 2018)	(2019 – 2023)
9.1	**Develop capacity for quality emergency response and recovery**					
9.1.1	Define and put in place clear policies, mechanisms and procedures	MKN, CKC/SEA Emergency Response Agencies	ESTABLISH 0.6	UPDATE 0.09	UDATE 0.15	UPDATE 0.15
9.1.2	Purchase suitable equipment and locate them near landslide-prone areas	CKC/SEA	3.05	0.60	3.75	3.90
9.1.3	Set up an emergency control centre with communication networks	CKC/SEA	3.50	0.40	1.00	1.00
9.1.4	Conduct inter-agency drills among various emergency response agencies	MKN, CKC/SEA Emergency Response Agencies	ESTABLISH 0.20	ON-GOING 0.15	ON-GOING 0.25	ON-GOING 0.25
9.2	**Provide necessary support, advice and forensic reports in landslide emergencies**					
9.2.1	Provide adequate and immediate support to emergency stakeholders in the aftermath of landslides	CKC/SEA	0.10	0.15	0.25	0.25
9.2.2	Provide advisory and forensic services and help bring affected infrastructure to near normal operating conditions	CKC/SEA, JMG	3.80	5.70	9.50	9.50
		Sub Total	**11.25**	**7.09**	**14.90**	**15.05**
		Total	**48.29**			

9.5.6 Critical Success Factors

Critical success factors are the factors that are critical to the success of the achievement of the strategic thrust and the various strategies derived from it. In the case of the EPRR, the absence of a focus on this singular critical success factor - Quality Response - can be akin to a body getting about without a major organ or limb; its performance will always be below par (see **Table 9.18**).

Table 9.18: Critical Success Factors

Critical Success Factors	Description
Quality Response Fast efficient response in every landslide incident.	Landslide emergencies often happen without warning so a fast response is critical as lives are normally lost within the first few hours. To achieve this, there must be continuous exercises in drilling, in procedures and in equipment handling. Lessons learned from every landslide must be distilled and implemented for continuous improvement to take place. To ensure a continuous supply of professionally trained emergency response personnel, ways must be found to make slope management and landslide management a professional career as it is not a job which anybody can fill without a period of long and continuous training.

9.5.7 Key Performance Indicators

Key performance Indicators is an objective and quantifiable mode of gauging whether the strategic thrust and the accompanying strategies are delivered. If not, KPI monitoring will give an indication of the shortfall, enabling adjustments to be made (see **Table 9.19**).

Table 9.19: Key performance indicators targets

Critical Success Factor	Key Performance Indicators	Target		
		Phase 1	Phase 2	Phase 3
Quality Response Fast, efficient response in every landslide incident	Response of EPRR geotechnical engineers within one hour in a high-risk area	At least 70% of response	At least 80% of response	At least 90% of response
	Forensic investigation reports to be produced and made available as targeted			
	• Inspection Report within 2 days	90%	95%	100%
	• Preliminary Report within 2 weeks	90%	95%	100%
	• Final Report within 3 months	90%	95%	100%

9.5.8 Outcome

The outcome of the measures presented in this report is the establishment of a coherent and systematic approach in responding to landslides. This approach in anticipating, assessing, preventing and preparating through continuous drills will enable EPRR teams to meet the quality response targets, thus ensuring that lost live and damaged property are minimised. The strategies, action plans and key performance indicators will propel EPRR response to a level where the destructive effects of landslides reduced to a degree not possible before.

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APPENDICES

Appendix 1: Typical Type B Ambulance Specifications

No.	Medical Instruments / Equipment	Minimum Specifications
1.	**ELECTRICAL SYSTEM**	a) System voltage -12 volts b) Capacity of battery - 50 Ah c) Alternator capacity - 14V/75 A
2.	**AIR CONDITIONING**	a) Capacity/Refrigerant -16000 BTU/R 134 b) Control - Individual control front and rear c) Outlet type - Eye-ball d) Type of compressor - Rotary Type
3.	**RUNNING EQUIPMENT AND FITTINGS**	a) Headlamps, side lamps, stop lamps, number plate lamps, reflectors, reverse lights hazard warning light b) Flashing direction indicators at front, side and rear of vehicle with self-cancelling device c) Loud Horn d) Heavy-duty three speed twin electric windscreen wipers e) One rear view mirror in cab and two external rear view mirrors f) Km/h speedometer and distance recorder g) Dipswitch and distance recorder h) Two sun visors i) Standard set of driver's toolkit including jack, fluorescent jackets, safety helmets, wheel brace and reflective safety triangle j) Front and registration number plates bearing the correct registration number k) Standard safety belts for drivers and passengers seat. Safety belt shall conform to Malaysian Standard M.S. No.6.3/1972 l) Two Suitable Dry Powder portable Fire Extinguisher conforming to Malaysian Standard M.S No. 6.21/1977 complete with robust mounting brackets fitted in the driver's cab and passenger's compartment m) A 24-hour clock in the driver's instrument panel.

4.	**PATIENT COMPARTMENT**	a) BODY PANELS i) Material - Fibreglass ii) Retardant class - Class II iii) Standard - 825 FR b) LINING i) Material - Fibreglass ii) Type of joint – Rivets c) PADDING i) Fibreglass d) FLOOR i) Material - Marine plywood covered with non-slip rubber matting ii) Thickness - 13mm e) INSULATION i) Material - Fire retarding fibreglass with heavy-duty thermal and acoustic treatment ii) Thickness - 38mm iii) Type of acoustic treatment - Fire retarding 500 series fibreglass iv) Type of thermal treatment - Fire retarding 500 series fibreglass f) WINDOWS i) Toughened shattering safety glass - 95% tinted ii) Sliding Type
5.	**EQUIPMENT AND FITTING**	a) PATIENT STRECTHER i) Model/Brand DYNAMED ii) Dimensions - 1930 x 560 x 810 mm iii) Straps iv) Ceiling Mechanism b) STORAGE CABINET i) Material - Fibreglass reinforced ii) Type of locking - Round clip hinging locks iii) Type of construction - Fixed (bolted fixed etc) iv) Label/signage c) NEARSEATS i) Number of seats ii) Material – PVC iii) Dimensions - 786mm x 410mm x 76mm (L X W X H) X 3 iv) Thickness - 76mm v) Foldable

		d) PARAMEDIC SEAT i) Material - PVC ii) Dimensions - 786mm x 410mm x 76mm iii) Thickness - 76mm iv) Rotation e) V HOLDERS f) SIGNAGE ON CABINET g) OXYGEN SUPPLY i) Type of Tank supplied - Aluminium Cylinder ii) Type of oxygen outlet iii) No of oxygen outlet : 2 iv) No of tank supplied : 1 v) Type of Tank Regulator - Brass Regulator vi) Transparent viewer h) WATER SUPPLY i) Tank - PVC Container (10 Litre) j) INTEGRATED LIGHT AND SIREN SYSTEM i) Make and model of beacon ii) Number of lamps : 6 iii) Type of lamps - Linear turbo strobe tube iv) Number of flashes/minute v) Housing Construction - Rigid light bar type vi) Dimension of light bar - 1000mm x 210mm x 140mm vii) Multiple type of tones k) OTHER EXTRAS- 2 sports lights, speaker and amplifier l) INTERIOR LIGHTING - Fluorescent type m) POWER SOCKET - 2 x 13 A S/S/O n) MOTOROLA GM338 BASE COMMUNICATION SET
6.	**PAINTING, COLOUR AND FINISHING**	a) COLOUR i) External - Light Ivory ii) Internal – White b) LITERATURE - User Manual - Service Booklet
7.	**MEDICAL DEVICES**	a) PORTABLE RESUSCITATOR - Dynamed b) CERVICAL SPINE IMMOBILISER - Dynamed c) SPINAL BOARD - Dynamed

		d) SPLINTING SET (PADDED BOARD & FRACTURE IMMOBILISER) - Dynamed e) TRAUMA BAG - Dynamed f) FOLDING POLE STRETCHER - Dynamed g) FOLDING SCOOP STRETCHER - Dynamed h) COT STRETCHER - Dynamed i) MANUAL SUCTION DEVICE - Dynamed

Appendix 2: List of Government Hospitals (Located at Landslide Prone Areas)

Bil.	Negeri	Nama Hospital & Alamat	No. untuk dihubungi	Bil. Katil
1	Johor	Hospital Kota Tinggi Jalan Lombong 81900 Kota Tinggi	No. Telefon: 07-8831131 No. Fax: 07-8831333 http://hkotatinggi.moh.gov.my	158
2		Hospital Sultanah Aminah 80100 Johor Bahru	No. Telefon: 07-2257000 No. Fax: 07-2841590 http://hsajb.moh.gov.my	989
1	Kedah	Hospital Langkawi Bukit Teguh 07000 Langkawi	No. Telefon: 04-9663333 No. Fax: 04-9660121	110
2		Hospital Sultanah Bahiyah KM 6, Jalan Langgar 05460 Alor Setar	No. Telefon: 04-7406233 No. Fax: 04-7350232/0233 http://has.moh.gov.my/	812
1	Kelantan	Hospital Gua Musang Bandar Baru 18300 Gua Musang	No. Telefon: 09-9121133 No. Fax: 09-9121302	34
2		Hospital Tanah Merah 17500 Tanah Merah	No. Telefon: 09-9557333 No. Fax: 09-9557929 http://hmerah.moh.gov.my	120
1	Melaka	Hospital Melaka Jalan Mufti Haji Khalil 75400 Melaka	No. Telefon: 06-2822344 No. Fax: 06-2841590	795
1	Negeri Sembilan	Hospital Tuanku Jaafar Jalan Rasah 70300 Seremban	No. Telefon: 06-7623333/7684000 No. Fax: 03-7625771 http://www.htjs.gov.my	850

Bil.	Negeri	Nama Hospital & Alamat	No. untuk dihubungi	Bil. Katil
1	Pahang	Hospital Bentong 28700 Bentong	No. Telefon: 09-2223333/2223334 No. Fax: 09-2224494 http://hspben.moh.gov.my	152
2		Hospital Cameron Highlands d/a Pejabat Kesihatan 39000 Tanah Rata	No. Telefon: 05-4911966 No. Fax: 05-4913355/49143555	25
3		Hospital Kuala Lipis 27200 Kuala Lipis	No. Telefon: 09-3123333/3123332 No. Fax: 09-3121787	128
4		Hospital Sultan Hj Ahmad Shah Jalan Maran 28000 Temerloh	No. Telefon: 09-2955333 No. Fax: 09-2972468 http://hoshas.moh.gov.my	420
1	Perak	Hospital Grik Jalan Intan 33000 Grik	No. Telefon: 05-7911333 No. Fax: 05-7911945	75
2		Hospital Ipoh Jalan Hospital 30450 Ipoh	No. Telefon: 05-2533333/2536052/2 No. Fax: 05-2531541 http://hipoh.moh.gov.my	990
3		Hospital Kampar Jalan Hospital 31900 Kampar	No. Telefon: 05-4653333 No. Fax: 05-4665664	90
4		Hospital Kuala Kangsar Jalan Sultan Idris Shah 1 33000 Kuala Kangsar	No. Telefon: 05-7763333 No. Fax: 05-7769660 http://hkangsar.moh.gov.my	136
5		Hospital Sungai Siput Jalan Felda Lasah 31100 Sungai Siput	No. Telefon: 05-5983333 No. Fax: 05-5971834	93
6		Hospital Tapah Jalan Temoh 35000 Tapah	No. Telefon: 05-4011333 No. Fax: 05-4010761	120

Bil.	Negeri	Nama Hospital & Alamat	No. untuk dihubungi	Bil. Katil
1	Perlis	Hospital Tuanku Fauziah Jalan Kolam 01000 Kangar	No. Telefon: 04-9763333 No. Fax: 04-9767237 http://www.htf.gov.my	404
2	Pulau Pinang	Hospital Pulau Pinang Jalan Residensi 10990	No. Telefon: 04-2293333 No. Fax: 04-2281737 http://hpinang.moh.gov.my	1090
1	Selangor	Hospital Kajang Jalan Semenyih 43000 Kajang	No. Telefon: 03-8736 3333 No. Fax: 03-8736 7527	306
2		Hospital Kuala Kubu Bharu Jalan Hospital 44000 Kuala Kubu Bharu	No. Telefon: 03-6064 1333 No. Fax: 03-6064 3039 http://hkkb.moh.gov.my	150
3		Hospital Selayang Lebuhraya Selayang-Kepong 68100 Batu Caves	No. Telefon: 03-61367788/61203233 No. Fax: 03-61377097	778
4		Hospital Tengku Ampuan Rahimah 41200 Klang	No. Telefon: 03-3375 7000 No. Fax: 03-3374 9557 http://htar.moh.gov.my	864
1	Sarawak	Hospital Kapit Jalan Memora 96800 Kapit	No. Telefon: 084-796333 No. Fax: 084-796136	134
2		Hospital Marudi Jalan Pungor 98050 Marudi	No. Telefon: 085-755511/755512 No. Fax: 085-7855217	54
3		Hospital Miri Jalan Cahaya Lopeng 98000 Miri	No. Telefon: 085-420033 No. Fax: 085-416514 http://hmiri.moh.gov.my	333
4		Hospital Umum Sarawak Jalan Tun Ahmad Zaidi Adruce 93586 Kuching	No. Telefon: 082-276666 No. Fax: 082-611124 http://hus.moh.gov.my	765

Bil.	Negeri	Nama Hospital & Alamat	No. untuk dihubungi	Bil. Katil
1	Sabah	Hospital Duchess of Kent KM 3.2 Jalan Utara 90000 Sandakan	No. Telefon: 089-212111 No. Fax: 089-213607 http://hdok.moh.gov.my	323
2		Hospital Keningau P.S 11 89007 Keningau	No. Telefon: 087-313000 No. Fax: 087-331595	212
3		Hospital Queen Elizabeth Karung Berkunci No 2029 88586 Kota Kinabalu	No. Telefon: 088-218166 No. Fax: 088-211999 http://qeh.moh.gov.my	589
4		Hospital Ranau 89300 Ranau	No. Telefon: 088-875266 No. Fax: 088-875223	91
1	Terengganu	Hospital Dungun 23000 Dungun	No. Telefon: 09-8443333 No. Fax: 09-8444160	92
2		Hospital Sultanah Nur Zahirah Jalan Sultan Mahmud 20400 Kuala Terengganu	No. Telefon: 09-6212121 No. Fax: 09-6221820	821
1	WP Kuala Lumpur	Hospital Kuala Lumpur Jalan Pahang 50586 Kuala Lumpur	No. Telefon: 03-26155555 No. Fax: 03-26911681 http://www.hkl.gov.my	2331
2	WP Putrajaya	Hospital Putrajaya Pusat Pentadbiran Kerajaan Persekutuan Persint 7 62250 Putrajaya	No. Telefon: 03-83124200 No. Fax: 03-88880137 http://www.hpj.gov.my	272

10. RESEARCH AND DEVELOPMENT

10. RESEARCH AND DEVELOPMENT

10.1 Oveview

10.1.1 Introduction

Landslides and related slope instability have become increasingly common in many parts of the world and are responsible for considerable losses in terms of both money and lives. With particular reference to Malaysia, landslide problems are worsening as a result of rapid economic development.

Given this situation, it is not surprising that landslides are becoming the focus of major scientific research, engineering study, and land use policy throughout the world. This particular component of the Malaysian National Slope Master Plan (NSMP) Study conceptualises the Research and Development (R&D) framework for the mitigation of landslide-related problems. From the findings of the literature review, technical visits, workshops and case studies, an R&D framework and programme are proposed as one of the important components for implementation.

10.1.2 Objectives

The objective of R&D is firstly to understand and review the need of R&D by other modules of the NSMP. Subsequently, it is to develop a predictive understanding of landslide processes, threshold values and triggering mechanisms. It aims to have better understanding on slope failure mechanism, causation factors and stabilization methods in the Malaysian context in order to reduce life loss and economical loss due to slope failures.

10.2 Problem Statement

10.2.1 Current Situation

Research and Development works encompassing analysis, design, subsurface characterization, monitoring, failure investigation and other aspects related to landslides conducted all around the world look for improvement on mitigation measures and prediction capability. Similarly in Malaysia, R&D works on the scientific knowledge of slopes are being carried out by local universities, consultants and government agencies.

However, there is a pressing need for coordination and collaboration among these agencies and relevant stakeholders to avoid duplication of role and responsibility with limited resources. Most of the R&D works by consultant engineers only focus on slope failures or studies of a localised area or zone, while the R&D works by local universities mainly focus on the testing of soil properties. These R&D works have also not looked into the problems in a holistic way and generally lack understanding of landslide hazards process, threshold values for various landslide triggering factors and other important aspects. Based on interviews and discussions with various agencies and stakeholders, the need for coordination and collaborative works among local governments, non-governmental groups, universities and engineering agencies are necessary.

Therefore, in order to achieve the aforementioned objectives, it is imperative to review the state of R&D works carried out by researchers around the world including Malaysia, through extensive literature review to extract the important findings on the causation, processes, threshold values and triggering factors of landslides. With consideration of variance in geological and climatic conditions, the findings from the review could provide a preliminary guide for the development of R&D framework and programme on landslides for Malaysia. In addition, the required R&D agenda by other modules of the NSMP is to be reviewed in order to cater for various aspects of R&D needs. Thus, further and detailed research framework could be proposed taking into consideration of the tropical weather, ground formation, common failure processes, current policy status on hillside development and slope engineering and management.

Further to the discussion with the Slope Engineering Branch (CKC) in the Public Works Department (JKR), there is general consensus among the project team that one of the important agenda in the preparatory stage of NSMP is the setting-up of a coordination agency, in which Cawangan Kejuruteraan Cerun (CKC) of JKR shall be upgraded to a Slope Engineering Agency (SEA). Further details on the roles and responsibility of the newly proposed Department have been elaborated under Policies and Institutional Framework (PIF) component. Meanwhile, the role of CKC/SEA from the R&D aspect will be illustrated in Section 10.4.3.

10.2.2 SWOT Analysis

A SWOT analysis was carried out as part of the study for the NSMP in identifying the inherent strength and weaknesses in hillside development and slope engineering and management in Malaysia. In addition, this section will also identify the observed opportunities and the anticipated threats after and during the implementation of the Master Plan. **Table 10.1** has tabulated a brief discussion on the identified factors and a brief description on the preliminary recommended action plan.

Table 10.1: SWOT Analysis

Item	Description	Action Plan	Remark
STRENGTH	***A) Resources*** (i) Human Resources • Sizeable geotechnical consultant	To tap practical knowledge for outsourcing	
	• Sizeable number of graduates in the course of Civil Engineering and Geology	Strengthen undergraduate training on slope engineering	Sufficient number of civil engineers to be trained for slope engineering
	• Good linkage with international bodies such as Hong Kong Geotechnical Engineering Office (GEO) and US Geological Survey (USGS).	Encourage information sharing through annual workshops and sharing of research facilities To identify Centres of Excellence (COE) for the specific field of slope engineering To tap experience for the setting-up of CKC/SEA	Establish more collaboration
	(ii) Facilities • 23 public and private universities available. 4 research-based universities.	To encourage emphasis on R&D and training and awareness on slope engineering	
	• Available venue from local institutions for R&D or training, such as CREAM in CIDB	To be used as venue for R&D and training	
	• Regional & international initiative [i.e. International Consortium on Landslides (ICL), GEO.	To establish annual workshops for the sharing of lesson learnt	

Item	Description	Action Plan	Remark
STRENGTH	(iii) Funding / Budget • Strong government initiative in tackling the lack of focus in the field of hillside development and management	To establish CKC/SEA with greater responsibility and budget for thorough hillside development and management	
	• Research funding is available	To formulate comprehensive R&D framework with prioritised funding and resources	
	B) Policy Enforcement and Administration • Establishment of CKC in 2003 to focus on hill site development and slope management	To establish CKC/SEA with enhanced resources	
	C) Others • As English (an International language) is widely spoken in the country, there should be no communication problem with foreign researchers/trainers and effective participation in foreign events	To encourage international collaboration	
	• Available case studies and case histories to form landslide database for the initiation of research and training directions/focuses.	To establish a Landslide Inventory template for the training programme	
WEAKNESS	**A) *Resources*** (i) Human Resources • Low emphasis on R&D and training on slope engineering and management.	To encourage via international collaboration and professional training	
	• Low incentives and poor remuneration for R&D and training staff	To establish recognition in COE to allow for more budget, hence better remunerations	
	• Lack of interest in the field of slope engineering and management	To encourage promotion of career in slope engineering and management	
	• Less research-based postgraduates on slope engineering/management	To increase research funding and awareness to create interest	
	(ii) Facilities • Lack of research facilities and research laboratories	To adopt and enhance facilities of COE	

Item	Description	Action Plan	Remark
WEAKNESS	• Lack of venues and opportunities for trainings	To adopt and expand usage of venue through other institutions or universities	
	• Lack of COE with specific R&D focus on various parts of slope engineering and management.	To create/identify and recognise COE within universities	
	(iii) Funding/Budget • Lack of funding/incentives for researchers by local authorities/ government sectors and industries/private sectors.	CKC/SEA to distribute research projects and funding	
	• Lack of continuous funding by government or industries/private sectors.	CKC/SEA to ensure continuous funding for slope engineering and management with yearly review of cost-benefit analysis of fund allocation	
	B) *Policy Enforcement & Administration* (i) Administration • Lack of systematically documented data, inter-agency and public information sharing.	CKC/SEA to be the custodian of landslide inventory, hazard and risk map and to have continuous review and updating of information for slope management.	
	• Lack of collaboration amongst agencies/academia/industries/ private sectors.	To establish constant collaboration via workshops	
	• Lack of disaster preparedness and operational exposure.	To formulate regular emergency drills together with other disasters and build up experience for participating regional and international landslide rescue operations	
	(ii) Policy Enforcement • Lack of policy empowerment at times, improper enforcement.	To promote awareness on slope engineering through media and road show for stakeholders To establish key performance index to assess the performance of policy enforcement	

Item	Description	Action Plan	Remark
WEAKNESS	• Lack of maintenance culture and integrated approach of overall hillside development and management	To standardise maintenance guideline and ensure enforcement	
	• Lack of persistency in follow-up and taking action		Working culture to be improved
	C) *Others* • Curriculum and course structure in universities/private institutions are insufficient to meet industry needs	To include industry stakeholders to improve course structure and modules	
	• Insufficient involvement of geotechnical engineers into R&D and continuous professional development (CPD)	To encourage involvement of practicing engineers in R&D within projects and publish findings	BEM has formulated enforcement on CPD points for all professional engineers More incentives, such as higher CPD points for R&D activities
OPPORTUNITY	***A) Resources*** • Establish CKC/SEA to implement NSMP • Establish COE of various aspects of slope engineering and management for R&D and training centre		To be proposed in NSMP
	B) Policy Enforcement and Administration • Enhance political will in improving current status of slope engineering and management in terms of technical advancement, preparedness of stakeholders and the awareness of the public. • Emphasis on safety and enhancement of slope engineering and management for new developments. • Provide prudent land usage and value-adding on hillside development.		Details stated in NSMP

Item	Description	Action Plan	Remark
THREATS	***A) Resource*** (i) Human Resources • Losing expertise/engineers to other countries due to global shortage of engineers and attractive remuneration reward offered by other developing countries.	To increase funding to retain experts To explore strategies in retaining engineers	
	(ii) Funding/Budget • Reduction in support of funding and resources allocation for slope engineering and management after the implementation of NSMP. • Attraction of funding may be diverted to other natural disasters.	CKC/SEA to publish performance KPI relating available resources and improvements on landslide management to justify the importance of sustainable funding to achieve the predefined target	
	B) Policy Enforcement and Administration • Lack of cooperation between agencies, industries and educational institutions.	NSMP to formulate system of information sharing	
	• Potential legal implications by private bodies/properties owners when devaluation of land value as a result of national hazard map developed and publishing high risk areas of landslide or areas prone to slope movement for administration of hillside development and management.	SEA is encouraged not to publish such information on media, but to make information available at the department where the public may enquire further. To legally exempt the published documents by CKC/SEA on slope management from litigation, but the legal framework shall mandate yearly review on the published documents to be carried out to rectify errors or improve accuracy.	CKC/SEA to be cautious in publicly information that may be against the comman good

Item	Description	Action Plan	Remark
	C) Others		
	• Inherent mentality on confidentiality and reluctance to information sharing by the agencies and private sector.	Master Plan to formulate a system of information sharing and remove the tendency to enforce confidentiality	

10.2.3 Needs and Constraints

Based on the various local literature reviews (Gue & Tan, 2006; Jamaluddin, 2006, Liew, 2004, Othman, 1994), the main causes of the frequent slope failures in Malaysia can be summarised as follows:

- Most failures are man-made slopes and most probably consist of less stable slope geometry created by development or human activities as a primary contributory factor. Rainfall is the main triggering factor of slope instability.
- Abuse in the use of prescriptive methods for slope design.
- Insufficient emphasis on the hydrological conditions of natural hilly terrain and the increase of surface runoff from the development after clearing of vegetation cover.
- Inadequate desk study and investigation to establish good geological and geotechnical models for slope analysis and engineering design.
- Limited resources for subsurface investigation.
- Improper design planning (poor building layout, alignment of road and utilities networks).
- Improper slope construction and lack of post-construction maintenance.

In view of the above causes, the need for a NSMP is timely and necessary for reduction in the loss of lives and financial losses.
The plan shall be applicable and enforceable to all slopes (man-made slopes and natural steep slopes, particularly those with high susceptibility to debris flow) which involve human activities (development) and have adverse effects on lives, high economical loss and environmental impact to the nation.

10.2.4 Stakeholders

Universities: consultants [Pertubuhan Akitek Malaysia (PAM), Institution of Engineers, Malaysia (IEM), Board of Engineers Malaysia (BEM), Association of Consulting Engineers Malaysia (ACEM)]: government agencies [Jabatan Pengairan dan Saliran Malaysia (JPS), Jabatan Kerja Raya (JKR), Malaysia Highway Authority (MHA)]: utilities and infrastructure companies [highway concessionaires, Syarikat Bekalan Air Selangor (Syabas), Tenage Nasional Berhad (TNB), Keretapi Tanah Melayu (KTM), Petroliam Nasional Berhad

(Petronas), Telekom Malaysia Berhad (Telekom)] are identified as the target audiences and major stakeholders in the implementation of the R&D components.

10.2.5 R&D Focus

As mentioned in earlier, most of the R&D works done in Malaysia and only focus on slope failures or studies of a localised area or zone (by local consultant engineers) and testing of soil properties (by local universities). The general inadequacy of R&D works necessitates research on aspects of landslide process mechanism and refinement of current stability models with some emphasis on monitoring methods. As such, in conjunction with the objectives and strategies of this component, an integrated research programme is recommended to focus on the following:

- Improve site characterisation and simplified laboratory techniques to obtain representative slope engineering parameters
- Obtain greater understanding of landslide process and movement mechanisms
- Develop/refine models to predict failure timing, location and ultimate mass displacement
- Develop new field monitoring methods

10.2.6 R&D Needs for the Entire Master Plan

Most of the above-mentioned aspects of R&D works are inter-related within the modules of the Master Plan. In fact, R&D works are required for all modules of the Master Plan, particularly:

- Hazard Mapping & Assessment (HMA)
- Early Warning System & and Real-Time Monitoring System (EW&RTM)
- Loss Reduction Measure (LRM)
- Public Awareness and Education (PAE)
- Information Collection, Interpretation, Dissemination and Achieving (ICIDA)
- Loss Assessment (LA)
- Emergency Preparedness, Response and Recovery (EPRR)

10.3 Detailed Study

10.3.1 Landslide Case Studies

This section includes a wide review of some of the various case studies carried out to extract important findings on the causation, processes, threshold and triggering factors on landslides. This section also aims to provide, through selective reference of worldwide literatures, a preliminary guide for future development of R&D works on landslides in Malaysia to mitigate landslides and reduce loss of lives and economic losses.

This section has been divided into two main sub-sections. The first sub-section reviews some of the case studies around the world including Malaysia to facilitate the development of the findings in the second sub-section, which details the contributory and triggering factors of landslides in the global and Malaysian context.

As an introduction, various approaches in defining and characterising landslides and its processes are detailed in Appendix 1, showing the commonly reported landslide classifications. Following from the original work by Varnes (1978), there has been significant growth in technical literature describing landslides since then. Among other literature, Varnes (1978), Cruden & Varnes (1996), Cornforth (2005) and Huat B.B.K. (2007) have been the main literature referred to for the characterisation of landslides.

10.3.1.1 Case Studies of Failed Slopes in Malaysia

This sub-section discusses the case studies with particular attention given to slope failure occurrences in Malaysia.

Jaapar (2006) compiled a list of some recorded landslides from newspaper articles between 1990 and 2004. The author attempted to record basic technical information about the selected landslides based on published literature and available archival data. Based on the literature review by the author, the causes of major landslide events can be summarised in **Table 10.2**. These statistics seems to suggest that man-made slope failures are prevalent in Malaysia. The complete list of landslide incidents has been compiled and enclosed in the Sectoral Report for Hazard Mapping and Assessment, Appendix 2.

According to Jamaluddin (2006), results of extensive studies on many cases of slope failures in Malaysia indicate that the slope failures are mostly attributed to human factors such as negligence, incompetence, lack or poor maintenance system, ignorance of geological inputs, unethical practice and various negative human attitudes. This is also supported in the paper by Gue and Tan (2006) where the authors have similar findings in their respective investigation cases on slope failures. Eighty-eight percent of the 49 cases of slope failures in Malaysia investigated by the authors are man-made slope failures due to either design errors or construction errors (see **Table 10.3**). These errors are mainly due to the lackadaisical human attitudes.

Table 10.2: Some recorded landslides between 1990 and 2004 (Jaapar, 2006)

No.	Date	Location
1	11.12.1991	KM 47, KL - Karak Highway, Pahang
2	17.10.1993	KM 32, Jalan Pahang to Cameron Highlands, Pahang
3	24.10.1993	KM 58, Kuala Lipis - Gua Musang road, Kelantan
4	14.11.1993	KM 32, Jalan Bentong - Kuala Lumpur
5	23.11.1993	KM 25.5 KL-Karak Highway, Pahang
6	28.11.1993	KM 63, KL- Karak Highway, Pahang
7	11.12.1993	Highland Towers, Selangor
8	15.12.1993	Kuala Lipis, Pahang
9	21.12.1993	KM 11, Jalan Puchong, Selangor
10	22.12.1993	KM 9, 20, 24, 25 and 26 of East- West Highway, Kelantan
11	25.12.1993	KM 62 and 70, Kuala Krai - Gua Musang road, Kelantan
12	28.12.1993	Kg Lereng Bukit, Miri, Sarawak
13	31.12.1993	KM 59.5, East-West Highway, Kelantan
14	22.03.1994	Fraser Hill, Pahang
15	02.05.1994	Puchong Perdana, Selangor
16	11.11.1994	KM 32, East-West Highway, Kelantan
17	15.11.1994	KM 33 , East-West Highway, Kelantan
18	30.06.1995	Genting Sempah, Selangor
19	05.07.1995	Rockfall, Batu Pahat, Johor
20	18.08.1995	KM 92 - 97, KL-Kuala Lipis road, Pahang
21	18.09.1995	Hong Seng Estate
22	19.09.1995	Penang Hill area, Penang
23	24.09.1995	Taman Bukit Teratai, Ampang, Selangor
24	16.10.1995	Bukit Tunku, Kuala Lumpur
25	24.10.1995	Tringkap, Cameron Highlands, Pahang

No.	Date	Location
26	31.10.1995	Tapah - Cameron Highlands road, Perak
27	09.11.1995	Teluk Bahang, Penang
28	20.11.1995	KM 27, Bahau - Tampin road, N. Sembilan
29	21.12.1995	KM 61, Bailey Bridge, Kuantan - Maran road, Pahang
30	23.12.1995	KM 19, Hulu Yam Baru - Sg. Tua road Selangor
31	25.12.1995	Jalan Belading, Tangkak, Johor
32	Dec-95	Cameron Highlands, Pahang
33	06.01.1996	KM 303.8, North-South Expressway, Gunung Tempurung, Perak
34	02.09.1996	Pos Dipang, Perak
35	09.10.1996	Kuala Terla, Cameron Highlands, Pahang
36	26.12.1996	Keningau, Sabah (part of Greg Typhoon)
37	Oct-96	Hye Keat Estate
38	15.10.1996	Kg. Chengkau Hilir, Remabu, N. Sembilan
39	18.10.1996	Cameron Highlands, Pahang
40	18.10.1996	Gelang Patah, Johor
41	11.05.1997	Pantai Dalam, Kuala Lumpur
42	28.11.1998	Paya Terubong, Penang
43	08.02.1999	Kg. Gelam, Sandakan, Sabah
44	15.05.1999	Bukit Antarabangsa, Selangor
45	28.11.1999	Bukit Aman, Penang
46	3.12.1999	KM 449.6 North South Expressway, Sg. Buloh Selangor
47	13.12.1999	KM 52, Johor Bharu - Ayer Hitam road, Johor
48	09.01.2000	KM 81.6, Tanah Rata - Brinchang road, Cameron Highlands, Pahang
49	18.01.2001	KM 16.1, North South Expressway, Skudai, Johor
50	22.09.2001	Sg. Chinchin, Gombak, Selangor
51	Dec-01	Gunung Pulai debris flow, Johor
52	28.01.2002	Ruan Changkul, Sarawak
53	20.11.2003	Taman Hillview, Selangor
54	26.11.2003	KM 21.8, North Klang Valley Expressway, Bukit Lanjan, Selangor
55	24.02.2004	KM 52, Tapah-Ringlet road, Cameron Highlands, Perak
56	11.10.2004	KM 302, North South Expressway, Gunung Tempurung, Perak

Table 10.3: Summary of the causes of major landslide events

Date	Location	Main Causes	Slope Type
11th Dec 1993	Highland Towers	- inadequate design - improper construction - triggered by rainfall	Man – made slope
30th June 1995	Genting Sempah Debris Flow	- triggered by heavy rainfall	Natural slope
6th Jan 1996	Gunung Tempurung	- adverse geological features - triggered by rainfall	Man – made slope
30th Aug 1996	Pos Dipang Debris Flow	- inadequate FOS - triggered by rainfall	Natural slope
28th Nov 1998	Paya Terubung Rockslide	- inappropriate design - triggered by rainfall	Man-made slope
7th Feb 1999	Sandakan Landslide	- inadequate FOS - triggered by rainfall	Natural slope
15th May 1999	Bukit Antarabangsa Landslide	- inadequate design - improper construction - triggered by prolonged rainfall	Man-made slope
28th Jan 2002	Ruan Changkul Landslide	- believed to be triggered by the rainfall	Man-made slope
20th Nov 2002	Taman Hillview Landslide	- inadequate design of the adjacent slope - triggered by rainfall - old landslide location	Man-made slope
26th Nov 2003	Bukit Lanjan Rockslide	- adverse geological condition - long term weathering - prolonged rainfall	Man-made slope

Table 10.4 : Summary of case histories adopted in Gue & Tan (2006)

No	Project Title	Cause of Failure				
		Design	Construction	Design & Construction	Geological Features	Maintenance
1	Landslide at Bukit Antarabangsa, Kuala Lumpur (15 May 1999) (man-made slope)			x		
2	Landslide at Lorong Setiabistari, Bukit Damansara,KL (01T112)	x				
3	Slope Failure at Expressway (01G126)	x				
4	Slope Failure at UTM Skudai, Johor Bharu (01E135)				x	
5	Slope Failure at UTM, Johor (01G139)				x	
6	KTM - Senawang Failure (01F143)	x				
7	Landslips Failure Adjacent to Taman TAR Development (01F148)					x
8	Landslips at Taman Hillview, Ampang, Kuala Lumpur (20 November 2002) (man-made slope) (02V212)			x		
9	Slope Failure to 6 Bungalows at Taman TAR, Kuala Lumpur (02V214)	x				
10	Slope Stability at College Hostels, Mukim Setapak, Wilayah Persekutuan (03E241)	x				
11	Slope Failure in Kupang, Kedah (Kupang To Gerik) (03F281)	x				
12	Slope Failure at Cerunan Tunku Bukit Tunku, KL (03F294)	x				
	Slope Failure at Expressway (9 slopes) (04G300)					
13	N4 (NB)	x				
14	N5 (NB)	x				
15	C1 (SB)	x				
16	C4 (NB)	x				
17	C5 (SB)	x				
18	S1 (SB)		x			
19	N5 (NB)			x		
20	S4 (NB)	x				
21	C3 (SB)	x				
	Slope Failure at Expressway (04G301)					
22	S1 (NB)	x				

No	Project Title	Cause of Failure				
		Design	Construction	Design & Construction	Geological Features	Maintenance
23	Slope Stability Along Road to Bungalows at Damansara (04E304)		x			
24	Landslide at Jalan Tanah Rata - Ringlet, Cameron Highlands (04F311)	x				
25	Slipped Rock Face at Tunnel Portal of Expressway (04E313)	x				
26	Cut Slope Failure at Highway (04G320)		x			
27	Slope Failure at Bungalow At Taman Yarl (04F343)			x		
28	Slope Instability at Ipoh (04F368)		x			
29	Slope Erosion Near Road at Damansara (04E378)	x				
30	Slope Failure at Hill 8 Of Section C1 (05E408)	x				
31	Slope Failure at Mukim Tanjong Dua Belas, Daerah Kuala Langat (05F425)			x		
32	Slope Failure at Keningau - Kimanis Road, Sabah (05F427)	x				
33	Landslide at An Island Resort (05F439)	x				
34	Landslide at College Hostels (00F033)			x		
35	Landslide at Mukim Setapak, Kuala Lumpur (00P074)			x		
36	Landslide at 5 blocks of Apartment, Bandar Baru Salak Tinggi, Mukim Dengkil, District of Sepang (00P078)	x				
37	Slope Failure at 22 Units Luxury Apartments Bkt Bandaraya, KL (04E347)	x				
38	Landslide at 5-storey Apartment, Bukit Beruntung, Selangor (99F028)			x		
39	Landslide at Jalan Raya Simpang Pulai - Lojing Gua Musang - Kuala Berang (01E098)				x	
40	Slopes Failure at Tinggian Tunkum 50480 Kuala Lumpur (00E094)					x
41	Slopes Failure at Highway (01G115)	x				
42	Slopes Failure at Kg. Sungai, Hanching, Mukim Berakas, Daerah Brunei (99E022)	x				
43	Slopes Failure at Jalan Bukit Pantai, Bangsar, Kuala Lumpur (01F099)	x				
44	Slopes Failure at Jalan Raja Chulan, Kuala Lumpur (02F179)					x
45	Slopes Failure at Bukit Sentosa (01E106)			x		
46	Slopes Failure at Bukit Beruntung, Selangor (01F147)	x				
47	Slopes Failure at Mukim Hulu Kelang, Daerah Gombak, Selangor (03E250)	x				
48	Slopes Failure at Slopes Of Mixed Development At Sungai Buloh (99F001)	x				
49	Slopes Failure at Sg. Midah, Alam Damai, Cheras, KL. (02E219)			x		

10.3.1.2 Identification of Contributory and Triggering Factors

This sub-section discusses the contributing and triggering factors that cause the occurrence of landslides. It should be noted that there can be several contributing factors but there is usually one dominant factor that triggers the landslides at the time of failure. On other hand, it should also be noted that in some cases, landslides may occur without an apparent triggering factor.

10.3.1.2.1 Landslide Contributing Factor

Based on the review of selected worldwide literatures and case studies, the main contributing factors are found to be as follows:

- Geological causes/ground conditions
- Hydrogeological causes
- Morphological causes
- Physical causes
- Human causes (design and construction)/Man-made processes

The apportionment of each of the contributing factors based on worldwide literatures and case studies is presented in **Figure 10.1**. Apart from Malaysia, selective representative literature review and case studies were also carried out with references from countries such as China, Italy, Thailand, Australia, Indonesia, Russia, Taiwan, Greece, Brazil, Germany, Korea, Japan and the United State of America. A total of 30 case studies excluding Malaysian case studies were included in the statistics as shown in **Table 10.5**.

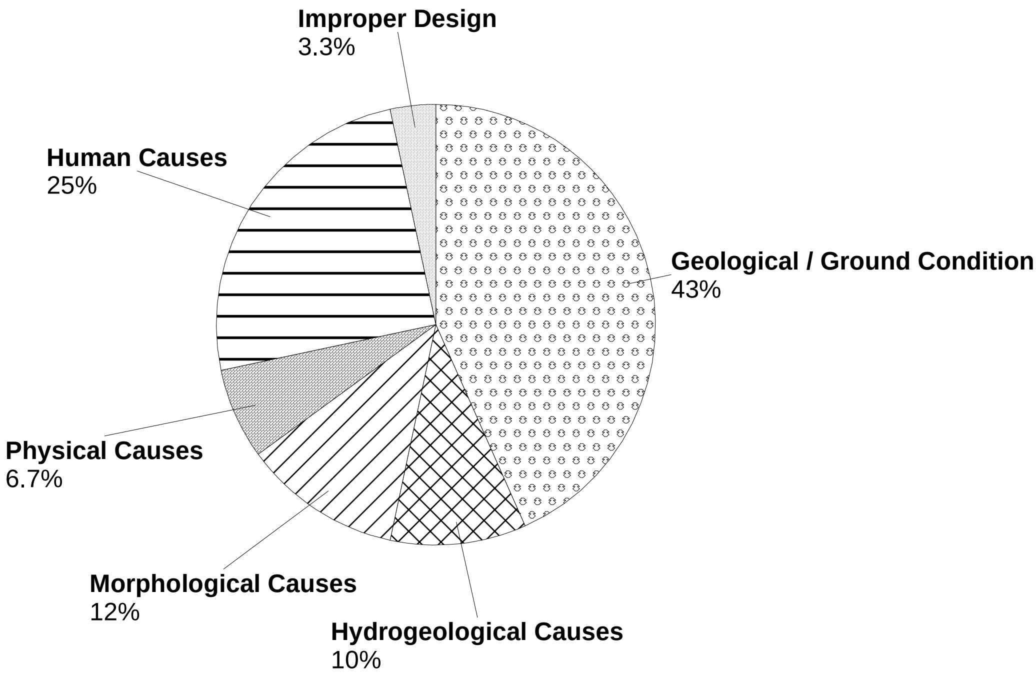


Figure 10.1 : Contributing factors of landslides based on selective worldwide literatures

The worldwide statistics (see **Table 10.5**) from **Figure 10.1** indicate that ground conditions and human causes (design and construction errors) are the major contributing factors of landslide failures on a worldwide basis. However, the situation is slightly different in Malaysia whereby the landslide failures mostly consist of manmade slopes which are caused by design errors or construction errors (human causes) (see **Figure 10.2** for statistics). Unlike Malaysia, the worldwide slope failures mostly consist of natural slopes.

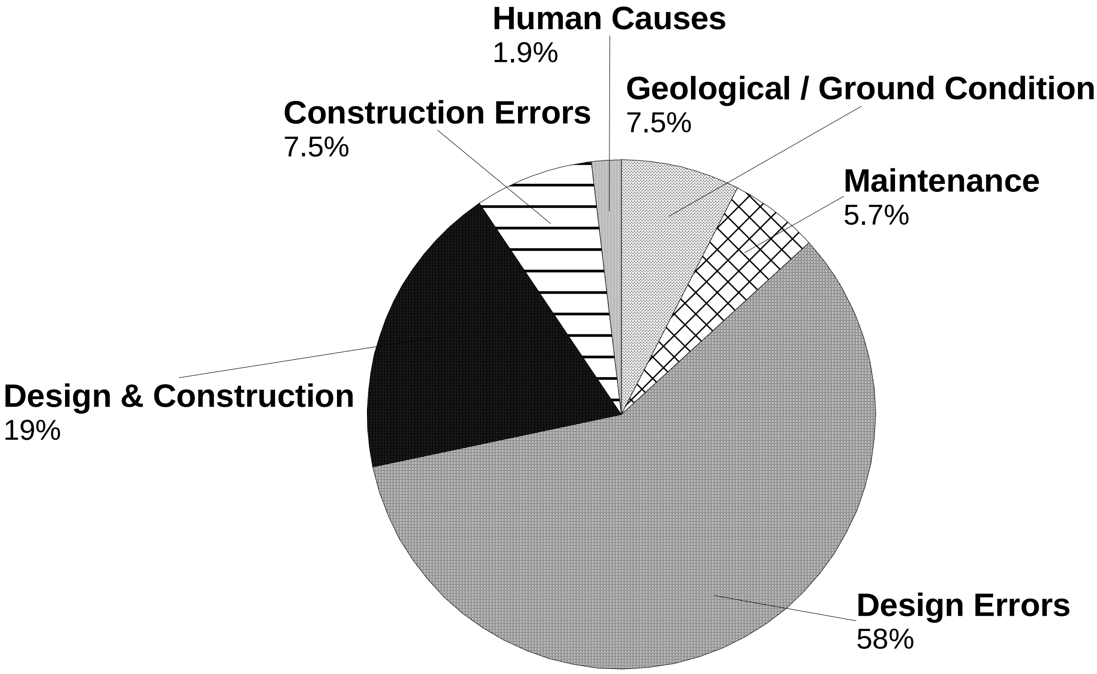


Figure 10.2 : Contributing factors of landslides based on Malaysian case history

With specific reference to Malaysia, the causes of landslides can be summarised as follows:

- Abuse of prescriptive methods
- Inadequate study of past failures
- Design errors (including insufficient site-specific ground investigation)
- Lack of understanding on testing and care
  - Lack of maintenance
- Lack of appreciation of water
  - Underestimating existing groundwater table
  - Inadequate capacity of surface drainage
- Construction errors
- Combination of the above

In any case, human causes (design and construction errors) can be prevented provided that precautionary measures are carried out with due diligence. The risk of landslides can be mitigated with proper assessment of the effect of ground conditions and foreseeable construction activities to the surrounding slopes during design and construction stages.

Appropriate design of slope strengthening works shall then be carried out based on the stability assessment. In the post construction, a proper maintenance scheme can be continued to upkeep the stability condition to the desired design expectation.

Table 10.5 : Summary of adopted worldwide literature for statistics on landslide contributing factors and triggering factors

No	Paper Title	Country
1	Slope Deformation Study with Ann Method in TGP (**3 Gorges**)	China
2	Post Failure Activity of the 1989 Caramanico Landslide (**Italy**) - Implications for a Road Tunnel Planned Upslope	Italy
3	Stability and Risk Assessment of PIT Walls at BHP Iron Ores' **Mt Whaleback Mine**	Australia
4	Factor Influencing Shear Strength and Slope Failures in Basalt Soils of North Eastern, **New South Wales**	Australia
5	Stability Analysis and Deformation Behaviour of Large Excavated Rock Slopes	Others
6	Performance of Stabilised Large Excavated Slope	Others
7	Stability Assessment of An Unstable **Rhyolite Cliff**	USA
8	The Application of Rock Mass Rating and Slope Mass Rating on Slope Cutting at a Section of Liwa-KRUI Roadway, **West Lampung**	Indonesia
9	Geological and Geotechnical Investigation of Land Movement at Citatah Area, West Java Province, **Indonesia**	Indonesia
10	Step Path Method for Slope Risks	Others
11	A Matrix Approach for Assessing Landslide Risk in the Context of a Comprehensive Strategy	Others
12	Alternative Approaches of Rock Slope Stability Analysis	Others
13	Landslides in **The Russian Far East**	Russian
14	A Study on the Failure Mechanism of the Slopes of the Lateritic Terraces in **Central Taiwan**	Taiwan
15	Heavy Rains and Mass Movements In Loose Volcanic Formations, Examples from Sarno (**Italy**) and Lesvos Island (**Greece**)	Italy, Greece
16	Monitoring A Creep Process on An Expansive **Brazilian** Soil	Brazil
17	Landslide Assessment at the Archeological Site of Agrigento (**Sicily, Italy**)	Italy
18	Large Scale Slow Movements on the Apennines (**Italy**)	Italy
19	Debris Flow Initiation Mechanism In Residual Soils	Others
20	Landsliding of the South Coast Railway - The **Coalcliff Slide**	Australia
21	Landslides in Permian Glacial Sediments, **Yankalilla**	Australia
22	Mechanism of Slope Failure in Izumi Group Due to Cutting	Others
23	The Brattas Landslide In **St. Moritz**	Switzerland
24	The Stability of Slopes Characterised by Colluvium - Investigation, Analysis and Stabilisation	Others
25	Engineering Geological Investigation and Evaluation of Landslides Behind An Upper Reservoir of Pumped Storage Station	Others
26	A Study of Stability in a Large Excavated Slope with Local Torrential Rainfalls	Others
27	Assessment on Mechanism of Rain Induced Landslide by Slope Hydrodynamic Simulation	Others
28	Stability of Slopes in the UNESCO World Heritage Messel Pit (**Germany**)	Germany
29	Investigation and Analysis of a Slope Failure in **Korea**	Korea
30	Technical Recommendations Arising from Lessons Learnt from Landslides in 1997 and 1998	Others
31	A Case Study of the 13th January 2004 Large Scale Rock Failure in Hokkaido, **Japan**	Japan
32	Mass Movements in the Loja Basin - Ecuador, **South America**, International of Landslide Risk Management	Ecuador
33	Investigation and Analysis of A Slope Failure in **Korea**	Korea
34	Beaver Shoreline Erosion	Others
35	Bonners Ferry Slide	Others
36	Highland Towers (11 Dec 1993)	Malaysia
37	Genting Sampah Debris Flow (30 June 1995)	Malaysia
38	Gunung Tempurung Slope Failure (6 January 1996)	Malaysia
39	Pos Dipang Debris Flow (30 August 1996)	Malaysia
40	Paya Terubung Rockslide (28 November 1996)	Malaysia
41	Sandakan Landslide (7 February 1999)	Malaysia
42	Bukit Antarabangsa Landslide (15 May 1999)	Malaysia

No	Paper Title	Country
43	Ruan Changkul Landslide (28 January 2002)	Malaysia
44	Taman Hillview Landslide (20 November 2002)	Malaysia
45	Bukit Lanjan Rockslide (26 November 2003)	Malaysia
46	49 cases by Gue & Tan (2006)	Malaysia

10.3.1.2.2 Landslide Triggering Factors

Based on various literatures carried out, the most common landslide triggering factors can be summarised as follows:

a. Intense rainfall (Major factor)
b. Rapid snowmelt (No relevance)
c. Water level change (Major factor)
d. Volcanic eruption (No relevance)
e. Earthquake shaking (No relevance)
f. Change of slope geometry (Major factor)

Similarly, the apportionment of the landslide triggering factors is presented in **Figure 10.3**. However, only factors (a), (c) and (f) are deemed relevant in the Malaysian context.

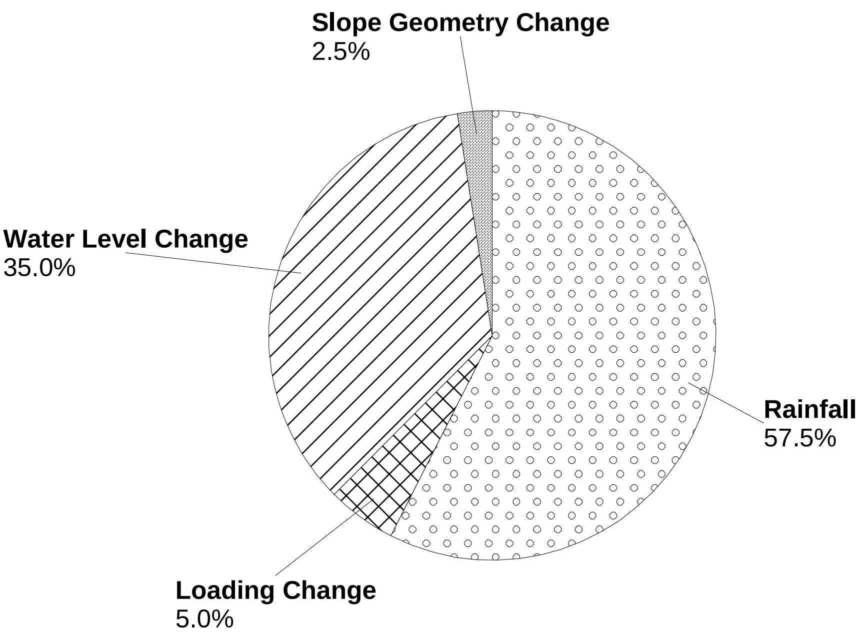


Figure 10.3 : Landslide triggering factors based on selective worldwide literatures

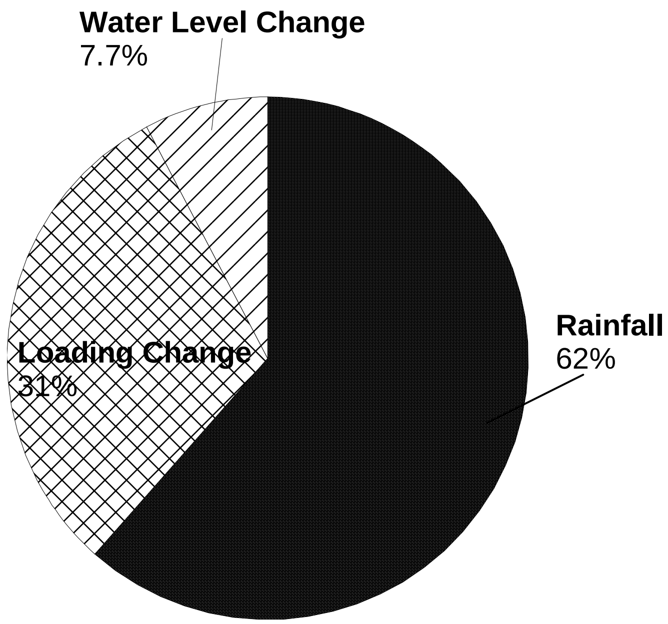


Figure 10.4 : Landslide triggering factors based on selective Malaysian case history

10.3.1.2.3<u>Relevance to Malaysia Conditions</u>

Based on the literature review, a summary of landslide contributory and triggering factors is presented. However, not all of the factors are applicable to Malaysian conditions. The rainfall, groundwater level, geological conditions and human causes/man-made processes are identified as the main causes of the slope failures in Malaysia.

As described earlier, human causes are particularly prevalent based on the paper by Gue & Tan (2006) where the **majority (88 percent) of the slope failures in Malaysia investigated by the authors are man-made slope failures** due to either design errors or construction errors. The authors also mentioned that only a small percentage of slope failures investigated in Malaysia are caused by geological features.

It is a well-known fact that in a tropical climate with a continuous heavy and prolonged rainfall during the two monsoons in a year, slope failures in Malaysia are not uncommon. As such, the effect of expected intense rainfall on the slope stability should have been taken into account in the slope design. Despite that, there are yet many reported slope failure cases, particularly man-made slope failures in Malaysia.

10.3.2 R&D Works Carried Out in Malaysia

Malaysia has a total of 29 public and private universities as listed in **Table 10.6**.

Table 10.6 : List of Universities and University Colleges in Malaysia.

No.	UNIVERSITY / UNIVERISTY COLLEGE	
1	University Malaysia Sarawak	UNIMAS
2	Multimedia University	MMY
3	Open University Malaysia	OUM
4	University Malaysia Sabah	UMS
5	University Utara Malaysia	UUM
6	University Kebangsaan Malaysia	UKM
7	University Tenaga Nasional	UNITEN
8	Malaysia University of Science and Technology	MUST
9	University Tunku Abdul Rahman	UTAR
10	Universiti Teknologi Petronas	UTP
11	Universiti Tun Abdul Razak	UNITAR
12	University Kuala Lumpur	UNIKL
13	Wawasan Open University	WOU
14	University Malaysia Pahang	UMP
15	University Malaysia Perlis	UNIMAP
16	University Malaysia Terengganu	UMT
17	University Industri Selangor	UNISEL
18	Universiti Teknologi Mara	UiTM
19	University Tun Hussein Onn Malaysia	UTHM
20	University Putra Malaysia	UPM
21	University Technology Malaysia	UTM
22	University Malaya	UM
23	University Sains Malaysia	USM
24	Sunway University College	SUNWAY
25	HELP University College	HELP
26	INTI University College	INTI
27	BINARY University College	BINARY
28	Kuala Lumpur Infrastructure University College	KLIUC
29	University College Sedaya International	UCSI

Among the above universities, four of them are categorised as research universities, which are, UM, UPM, UKM and USM. However, none of the above universities has a dedicated research centre for slope engineering. As such, only minimal and ad-hoc research has been carried out in this aspect by local Institutions of higher education. **Table 10.7** shows some research related to slope engineering carried out in Malaysia.

Table 10.7 : Part of the Research Done in Malaysia Related to Slope Engineering

Areas of Interest	Related Publications
Basic and applied research in tropical residual soils engineering	Huat et. al. (2004), Tan & Chow (2004), Abdullah et. al. (1994), Hossain (1999), Liew (2004)
Unsaturated soil mechanics	Gasmo et. al. (1999)
Soil infiltration characteristics in unsaturated residual soil	Huat et. al. (2005a)
Suction and rainfall response in unsaturated residual soil	Huat et. al. (2005b), Huat et. al. (2005c), Ng et. al. (2000)
Suction and saturation of unsaturated soils	Ali & Rahardjo (2004)
Collapse behaviour (volume change)	Huat et. al. (2005g), Huat et. al. (2006a)
Laboratory equipments for testing of unsaturated soils	Huat et. al. (2005e & f)
Slope stability analyses incorporating suction and varying hydrological conditions	Huat et. al. (2006a)
Bioengineering for stabilisation of slopes	Huat et. al., (2005d), Ali & Barakbah (2002), Abd Rahman (2002), Amin et. al. (2002)
Slope assessment system	Hussein et. al. (2004), Jamaludin (2006)
Hazard mapping	Ab. Talib (2001, 2004), Chow & Mohamad (2002), Jamaludin et. al. (1999)

10.3.3 Questionnaires

10.3.3.1 Questionnaires to Stakeholders

Upon carrying out literature review and conducting interview with various agencies the findings suggest that research on the following aspects are necessary:

- Methods to simplify acquisition and interpretation of strength parameters on the slope materials, especially at formations with frequent slope failures
- Hydrology and hydraulic conditions of slope surface runoff and hydrogeological conditions of sub-terrain infiltration and seepage
- Methods to assess weathered rock strength and rock mass strengths
- Methods to assess the groundwater table in relation to duration and intensity antecedent rainfalls
- Method to determine clay seam layer
- Shear strength and pore-water pressure characterisation
- Prediction of rainfall with meteorological radars and rain gauge station for early warning
- Development of available and new slope stabilisation techniques (slope surface erosion protection, slope mechanical stabilisation system, subsoil drainage system)

10.3.3.2 Questionnaires to Universities

Further to the general questionnaires forwarded to the stakeholders, a research specific questionnaire was devised and forwarded to seven major research-based universities (i.e. UM, UTM, UKM, UPM, UiTM, USM, UMS) to acquire the status of both their capability and capacity on local research and development activities. To enhance the interaction and exchange of view, a one-day workshop was organised by CKC where local research works related to slope engineering and management were presented by the local experts from the following professions, and is tabulated in **Table 10.8**:

- Slope Engineering
- Engineering Geology
- GIS and Remote Sensing
- Meteorology/Climatology

Table 10.8 : Summary of R&D Focuses of Local Universities

University	R&D Focus	Main OnGoing Projects
UM	Slope Engineering	• Monitoring of Soil Suction via Laboratory Testing & Numerical Analyses
	Hazard / Risk Mapping	• Terrain Classification Mapping
	Eco-Engineering	• In-Situ Root Pull-Out Testing • Numerical Analyses on Root Strength
	Climatology	• Global Land Temperature Trend
UTM	Structural Earthquake Engineering	• Seismic Hazard & Risk Studies • Surface Acceleration Contour
	Slope Engineering	• Slope Analyses • Landslide Assessment & Reliability Analyses • Slope Rehabilitation Studies
	Engineering Geology	• Geological Mapping • Geological Discontinuities Studies
	GIS and Remote Sensing	• Remote Sensing Interpretation • Statistical Rainfall Analyses
UPM	Slope Engineering	• Modeling of Karst Landform • Development of Strength Measuring Device • Slope Assessment System
UKM	Tropical Climate Change	• Effect of Global Warming on Tropical Monsoon • Rainfall Variability & Predictability
UiTM	Landslide Hazard/Risk Mapping	• Rainfall Data Analyses • Landslide Risk Mapping • Soil Physical Analyses
USM	GIS & Remote Sensing	• Risk Assessment on Slope Failure In Penang Island
UMS	Earthquake Induced Hazard Mapping	• Engineering Properties of Trusmadi & Crocker Formations • Geological Studies of Active Faults • Geological Mapping of Active Faults

Among the above universities, some of the universities have established research centres related to the field of either geotechnical engineering, engineering geology, GIS and remote sensing and/or climatology. **Table 10.9** has tabulated the recommended centres of excellence (COE) of the relevant professions in this study and the existing research centres.

Table 10.9 : Recommended centres of excellence by Malaysian universities

University	Recommended COE on the following field of expertise	Existing Research Centre
UM	Hazard/Risk Mapping Slope Engineering Eco-Engineering Climatology	-
UKM	Tropical Climate Change Engineering Geology	-
UMS	Earthquake Induced Hazard Mapping	Centre for Natural Disaster
UPM	Slope Engineering Slope Assessment Systems	Mountainous Terrain Development Research Centre
UTM	Slope Engineering	-
	Earthquake Induced Landslide	Structural Earthquake Engineering Research Group (SEER)
	Engineering Geology	Geotechnical Engineering Research Group
USM	GIS & Remote Sensing	-
UiTM	Landslide Hazard/Risk Mapping	National Soil Erosion Research Centre (NASEC)

10.3.4 Site Visits

Technical visits to Japan and Hong Kong were carried out from 17th to 27th September 2006 and 11th to 15th December 2006 respectively. The information obtained pertaining to the R&D works during the technical visits is summarised in **Table 10.10**.

10.3.4.1 R&D Works by Other Countries

Table 10.10 : Summary of Research Capability and R&D Works Carried Out by Other Countries

Research Centre	Summary of Research Capability and R&D Works Carried Out by Other Countries
JAPAN	
Research Centre on Landslides (RCL) of Disaster Prevention Research Institute (DPRI) of Kyoto University	Human Resources: o 12 full time researchers o Total academic staff is about 100 RCL has been carrying out the following R&D works in their organization: a. Conducts research on the mechanisms of initiation and motion of landslides triggered by earthquakes and rainstorms. b. Initiates effort for real-time prediction of rapid and long-travel landslides, the development of landslide monitoring and warning system in a global scale, and new techniques of landslide field investigation and instrumentation. c. The main topics of research and education in RCL includes: • Initiation and run-out mechanisms of landslides triggered by earthquakes and heavy rains • Reliable landslide risk evaluation and hazard zonation for densely populated urban areas, cultural and natural heritage sites • Development of high-precision and reliable monitoring system of landslides from a local scale to a global scale • Field investigation and development of instrumentation for landslide research • Education and capacity building to reduce landslide disasters in developing countries RCL does not carry out research in remote sensing and early warning system.
Sakurajima Volcano Research Centre, Disaster Prevention Research Institute, Kyoto University	The following observation network is available at this centre:- ▪ Seismometer (measuring movements in three directions) ▪ Seismometer and broadband seismometer ▪ Borehole tiltmeter ▪ GPS

Research Centre	Summary of Research Capability and R&D Works Carried Out by Other Countries
	▪ Tide gauge, etc.
Research & Development Centre of Nippon Koei (presented by S.Kuraoka)	Facilities: o Land area of 67,000m^2 and 3000m^2 for the main building o 6,300m^2 for three laboratories; namely • Geotechnical Engineering and Environmental Science • Hydraulic Engineering Yard (an area of 7,000m^2) • Multipurpose o The centrifuge laboratory has capacity to deliver a centrifuge force of 250g. The diameter of the centrifuge arm is 5.2m and can hold a load of 1 tonne Human Resources: o The centre has 35 full time staff and a few part-timers Funding: o Funding is largely through competitive bids. o Ten years ago, 70 percent of the research funding came from their internal company's fund. Now only 30 percent of the funding is from their internal company's fund. - The research works are aimed to produce economical and reliable engineering solutions and develop new codes. The R&D Centre does not carry out fundamental research.
Main Area of Research Involved	
• Evaluation of Slope Stability by Neural Network (NN) (presented by I. Morita of Advanced Numerical Modelling Group) • Real Time System for Slope Stability Assessment (presented by M. Takahashi of Environment Science Group) • Slope Hazard Assessment using ASTER Data (presented by I. Morita of Advanced Numerical Modelling Group) • Rational Stabilization of Slope Applying Numerical Methods (presented by S. Kuraoka)	
HONG KONG	
Hong Kong University Science & Technology (by Prof. Charles Ng. W.W)	Facilities: o Centrifuge device of about 8m in rotating diameter with a maximum modelling capacity of about 400g-tonne. The entire cost of complete centrifuge test equipment is about US$2,000,000. The overhead cost of the operation team consisting of one engineer, three technicians, one computer officer and one administrative officer is about HK$1,500,000 annually. Generally, the research fund for HKUST centrifuge centre is 60 percent from government research fund and 40 persent from

Research Centre	Summary of Research Capability and R&D Works Carried Out by Other Countries
	commercial sectors. Currently, HKUST can carry out a centrifuge test at the cost of US$5,000 to 6,000 per test. o Four-axis robotic manipulator for the modelling of construction sequences and simulating earthquake by using the unique bi-axial shaking table. o The laboratory has almost every type of testing device except for ring shear and simple shear testing equipment. o HKUST has also invented a special device for measurement of volumetric changes of unsaturated soil sample.
Hong Kong University (Discussion with Prof. Andrew Malone)	o One of the important aspects that have not been incorporated in the plan is the establishment of the baseline of risk level at current condition in Hong Kong. Prof. Andrew Malone emphasized the importance of having this baseline with the quantitative risk assessment (QRA) to demonstrate the effectiveness of measures taken to relieve risk and justification for the financial resource from the government. o It is impractical to imitate entirely the GEO approach. From his experience, it is very heavy in financial commitment from the government. The yearly expenditure is about HK$1,000,000,000 from the central government and HK$600,000,000 from various government departments for Landslide Prevention Measure and Slope Maintenance programme. o Survey of past fatalities statistics by searching through newspapers can provide useful baseline data. It shall also never ignore those incidences that nearly become fatality cases in the statistics in order to have representative statistics. o In Hong Kong University, risk management has been taught in post-graduate engineering courses as it plays an important role in dealing with uncertainties, especially in geotechnical works.
Main Area of Research by Geotechnical Engineering Office (GEO)	

Research Centre	Summary of Research Capability and R&D Works Carried Out by Other Countries

- Landslip Warning System (presented by Sammy Cheung Ping-Yip of Standards and Testing Division)
- Landslip Investigation (Man Made Slopes)(presented by Tony Lau of Landslip Investigation Division)
- Natural Terrain Landslide – Risk Management in Hong Kong (presented by Samuel)
- The following focus of R&D Works

Table 10.1: Summary of Main and Current Focus of R&D Works in Hong Kong

Main Focus of Past R&D	Current Focus
Unsaturated soil properties	Soil nailing studies
Saprolite properties	Natural terrain landslide risk studies
Landslide studies	Landslide field studies
Slope design	Technical support to LPM (Landslide Preventive Measures) and other projects
Reinforced earth	Review of landslip warning criterion
Skin friction of bored piles	Field trial of stepped channel to verify their design capacity
Rainfall related studies	Measurement of alignment and diameter of soil nail holes
Quantitative Risk Assessment (QRA) on landslide risk	Review of load transfer mechanisms of soil nail heads
	Numerical modelling of soil nail head
	Review of performance of different new greening techniques on slopes

Hong Kong Strategic Plans	The strategic plans being carried out by the Geotechnical Engineering Office (GEO) are as follows: - The 1997 five-year Strategy Plan - The five-year Strategic Plan 2000-2005 - The five-year Strategic Plan 2006-2010 The strategies implemented by five-year Strategic Plan 2000-2005 are as follows: Strategy 1: Natural terrain landslide risk Strategy 2: Reliability and robustness of engineered slopes Strategy 3: Novel design schemes and construction methods Strategy 4: Technical policies and guidelines Strategy 5: Promulgation of geotechnical advances Hong Kong GEO has published various guidance documents, technical guides, technical papers and research reports for the public. These documents are made available to both private and public developments in order to promulgate geotechnical

Research Centre	Summary of Research Capability and R&D Works Carried Out by Other Countries
	standards set by the GEO.
Main Area of R&D Works by Arup's Office	
• Engineering and Risk Management of Slopes in Hong Kong (presented by Albert Ho of Arup) • Natural Terrain Hazard Studies in Hong Kong (presented by Mark Wallace of Arup)	
UNITED STATES (US)	
United States Geological Survey (USGS)	The United States Geological Survey (USGS) Landslide Hazards Program conducts research in order to make accurate landslide hazard maps and forecasts of landslide occurrences. Summary of Research Interest: a) Wildfire and Debris Flows ▪ In recent years, wildfires have ravaged many areas throughout the western U.S. Rainstorms that come in the wake of these fires often causes flooding and debris flows. ▪ The destructive debris flows have recently taken dozens of lives and caused many millions of dollars in damage. ▪ USGS research on debris flows in burned areas focuses on determining the conditions and processes that cause debris flows and rapidly assessing the potential for debris flow in specific burned areas. ▪ The wildfire would be equivalent to the deforestation by logging activities, agricultural and commercial developments in Malaysia. It would be useful to explore the findings from USGS on debris flow research. b) Precipitation-Induced Landslides ▪ Heavy precipitation is the primary trigger of landslides in the U.S. Years of above-average precipitation can reactivate old landslide deposits, and major storms or snow-melt events can trigger thousands of landslides across a region. ▪ USGS research on precipitation-induced landslides has focused mainly on developing predictive understanding of where and when landslides are likely to occur. ▪ In recent years, research has been conducted in selected areas of California, Colorado, Oregon, Virginia, and Washington. ▪ It will be informative to observe the effectiveness of their precipitation-induced landslides models for early warning system.

10.3.4.2 Relevance of Others R&D Works to Malaysia

In comparison to the R&D works carried out by Japan and Hong Kong GEO, Malaysia is still at its infancy stage. Based on the findings from interviews, the R&D works in Malaysia center around the scientific knowledge of slopes that have been carried out mainly in case studies on individual slope failures in local universities, consultants and public agencies. Unlike Japan and Hong Kong, Malaysia does not have a research centre (Centre of Excellence) to coordinate and integrate the R&D works carried out locally.

The main R&D works carried out in Japan (as mentioned in **Table 10.10**) are applicable to natural slopes conditions in Malaysia except for the research on mechanisms of initiation and landslide motion triggered by earthquakes in which there is currently no reported failure cases in Malaysia. So far, no slope failures related to earthquakes are reported although the effect of earthquake from neighbouring countries is experienced. The real-time monitoring system for slope stability assessment is adopted by Japan to determine the regulation of traffic and allowing traffic to use the road because there are significant numbers of roads that are inevitably located near the natural dangerous slopes which are too huge and expensive to strengthen. This monitoring system is important to mitigate road blockage due to slope failures that affect social and economic activities.

Slope hazard assessment using ASTER data in Japan may be conducted on large and dangerous natural slopes near main roads, highways and utilities in Malaysia. In any case, the current slope assessment system adopted by the highway concessionaires (such as PLUS) is currently not made available despite numerous attempts made to obtain such information. As such, any proposal to assimilate a proposed system to the existing system is currently not possible without such information.

In Hong Kong landslide prediction system, Hong Kong Observatory (HKO) adopted nowcasting system to predict the next three hours of rainfall with a prediction accuracy of 60 percent. However, the situation in Malaysia is slightly different in nature. It would be impractical to carry out monitoring and maintenance works on all slopes (particularly man-made slopes) in Malaysia because the cost of monitoring and maintenance works of such coverage is not justified. This view concurs with the opinion of Prof. Andrew Malone during a discussion on the technical visit to Hong Kong. Nevertheless, the nature of the landslide problems faced in Malaysia is similar to Hong Kong in that the majority of the failures are on man-made slopes. As informed by Hong Kong GEO, approximately 77 percent of the landslide occurred on the man-made slopes. However, the statistics indicate that man-made slope failures are more prevalent in Malaysia as compared to Hong Kong.

Currently, Malaysia does not possess any centrifuge device to facilitate further research on slope failure-related topics which can benefit from centrifuge modelling. In view of this and the very high cost of purchasing a centrifuge device, there is an opportunity of collaboration between Malaysia, Singapore (National University of Singapore) and Hong Kong pertaining to research that involves centrifuge modelling. As debris flow is also an occurring phenomenon to a small extent in Malaysia apart from Hong Kong, United States and other countries, particular attention shall be given to carry out fundamental research on formation and mechanism of debris flow. Literature review indicates that rainfall intensity and rise in soil moisture are often the debris flow triggering factors.

Similar to Malaysia, heavy precipitation is the primary triggering factor for landslides in the United States. As described in **Table 10.10**, USGS has focused mainly on developing predictive understanding of natural landslide occurrence. In view of this, a partnership between Malaysia and USGS can be explored for the development of predictive understanding of landslide occurrence.

10.3.5 Summary

In general, in order not to reinvent the wheel, it is suggested to extract the relevant areas in the R&D framework of Japan, Hong Kong and USGS with necessary modifications to suit the Malaysian condition (with particular reference to man-made slopes) and implement it in short, medium and long term plans.

As such, in line with the objectives of the master plan, the proposed research programme based on the above findings are categorised into five main categories as follows:

- Proposed research programme for landslide processes and mechanism
- Proposed research programme for characterisation of slope
- Proposed research programme for realistic scientific models

- Proposed research programme for dynamic landslide prediction system
- Proposed research programme for technology development and construction innovation

10.4 Recommended Strategies

10.4.1 Introduction

In view of the current R&D status in Malaysia and the potential for future improvements on landslide mitigation measures and prediction capability, the recommended strategy for this component will be the setting up of the R&D Steering Committee under CKC/SEA for an overall implementation and monitoring of all R&D works, both from macro and micro prospectives. The recommended strategy is also aiming for an effective means of capacity building within the nation in slope engineering and slope management for implementers at all levels, through R&D works and knowledge transfer.

10.4.2 Strategic Thrust

The strategic thrust of the R&D module within the implementation of the Master Plan shall be the establishment of R&D framework for the mitigation of landslide and solve landslide-related problems by developing a predictive understanding of landslide processes, threshold values and triggering mechanisms. With that, two strategies have been formulated for the above purpose and are tabulated in **Table 10.11**.

Table 10.11 : Strategic Thrusts

Strategic Thrust	Strategies
Enhance slope engineering and management through research and development	10.1 Develop a national framework for research and development and a multi-year implementation plan 10.2 Develop a national research and development programme

10.4.3 Strategies

Strategy 10.1	**Develop a national research and development framework and a multi-year implementation plan**
	Develop a national research and development framework and multi-year implementation plan based on the current state of scientific thresholds, and triggering factors with emphasis on how R&D works shall be structurally implemented
	10.1.1 Develop federal-state and public-private programmes to delineate landslide prone areas, to forecast the potential for landslides and to mitigate losses
	• Establish collaborative works with representatives of federal, state and local governments, academia and private industry. This is to assist in the coordination and implementation of the NSMP Study. This national strategy shall be able to enhance the ability of governmental agencies to collaborate effectively with both academic and private sectors to leverage shared resources. This continuous two-way communication among the agencies is necessary to ensure proper coordination at all levels.
	10.1.2 Assign, coordinate, collaborate and disseminate all research from the universities and industries to facilitate capacity building for local research
	• Outsource R&D works to accredited competent professionals and monitor the performance and deliverables of the service
	• Produce yearly operational budget for R&D works
	• Carry out and compile findings of forensic investigation on slope failures and publish yearly statistics of slope failure and lessons learned
	• CKC/SEA to be the permanent custodian of Landslide Inventory, Hazard & Risk Map with regular updating and maintenance

Strategy 10.1	Develop a national research and development framework and a multi-year implementation plan

- Identify industry-link or joint projects by the R&D steering committee (in a micro view) on project basis.

  The Master Plan has only identified research agenda at the macro stage. Leverage on the existing R&D resources such as COE, other research agencies and industries shall be given top priority in capacity building. In addition, CKC/SEA shall be open to welcome any proposal on slope-related R&D project in joint venture or collaboration basis.

  The research funding may or may not be from CKC/SEA, but allocation for such budget is necessary in the event where it has to be fully funded by CKC/SEA. Detailed arrangement of funding on project basis will be under the purview of the R&D steering committee.

  If the R&D topic is very critical and relevant for input to subsequent R&D, as such requiring to achieve specific target, then direct funding from CKC/SEA would be required in order to have project governance for the expected deliverable.

- Organise regular national slope engineering and management conference

- Mandate each research project to include a PhD student and each research project shall finally be published in the national and international conferences.

  This has the following advantages:

  - Comparatively low cost input
  - Capacity building
  - Improved linkage to the universities

Strategy 10.1	Develop a national research and development framework and a multi-year implementation plan

- Facilitate capacity building for local researchers

  In order to the ensure effective capacity building within the local research community, majority of the R&D works will be allocated to local research institutes, either in local universities or among local practitioners, who propose important industry-based application research. In addition, capacity building can also be achieved by sending students or employees from industry for research projects at international COE when appropriate. This will also promote collaboration between local researchers and the international COE such as Hong Kong, GEO and USGS.

  Research capacity shall be sustained by active participation of national and international conferences, workshops and seminars on presenting the R&D findings.

  A performance index system shall be introduced to benchmark local slope engineering experts towards international standard in the process of capacity building.

10.1.3 Set up a research network for quarterly review, practitioner feedback and peer evaluation

- Set up a research network by quarterly review on research findings and progress monitored by a R&D Task force committee and having an exchange platform in a yearly R&D seminar or conference on slope engineering. Such network will help upgrade quality and functionality of research findings may be guaranteed.

- Recommend the setting up a feedback system, in the form of a standard report, to ensure persistent involvement of practitioner with value adding comments even though their involvement is only on voluntary basis or paid on retainer basis.

  The practitioner involved in each research project shall be identified and monitored by the R&D task force committee at CKC/SEA.

  The most effective way to have feedback and input from practitioner community is via forum discussions after a R&D seminar or conference presenting all the R&D findings and progress. Such interaction will be a better way to achieve well-balanced research between fundamental and applied research.

Strategy 10.1	Develop a national research and development framework and a multi-year implementation plan

- Set up peer review mechanism. The review mechanism for R&D activities shall consist of a three-level independent peer review process, in which the appropriate reviewer shall be nominated from the review panel. The followings are the recommended reviewers at three levels:
  - via practitioner community
  - via slope experts within local COE (of the same field)
  - via international slope experts

10.1.4 Set up Research & Training Institution

When the scope of R&D and training activities increase beyond the control of human resource under CKC/SEA, the Research and Training Unit shall be upgraded to an independent institute so as not to affect the primary administrative role of CKC/SEA on slope management. Fully equipped facilities, such as research laboratory and training facilities, shall be provided in the institute.

The operation of the institute shall be fully funded without pressure of financial burden. However, clear objectives of every R&D activity and training module shall be critically scrutinised with convinced substantiation justifying the necessary operational budget. A cost-benefit analysis shall be performed for the funding of each proposal.

Strategy 10.2	Implement a national research and development programme

Develop a national research and development programme to identify the important R&D works to be done for improvement of current scientific knowledge, effective mitigation measures, effective landslide dynamic prediction system and mechanism for information sharing database related to slopes and slope engineering.

10.2.1. Implement a national research programme on slope engineering

- Implement national research programme on the characterisation of soil and rock slopes

- Implement national research programme on the understanding of landslide processes and mechanisms

Strategy 10.2	**Implement a national research and development programme**
	• Implement national research programme on more realistic scientific models of ground deformation and slope failure
	• Implement national research programme to establish and improve dynamic landslide prediction system
	• Explore the impact of climate change and global warming on landslide occurrence in Malaysia
	• Implement national research programme on technology development and construction innovation
	• Evaluate the future needs of the Master Plan due to social change
	10.2.2. Implement a national research programme on applied research that are directly usable by the practitioners
	Hazard Mapping and Assessments (HMA)
	• Enhance mapping techniques
	• Produce, revise and update slope susceptibility, hazard and risk maps These maps shall be at regional and national level including engineering data for the use of public, especially for the desk study by the consultants when developing a project
	• Enhance sharing of database for the production and refinement of hazard and risk maps
	• Establish the vulnerability of elements at risk This involves the establishment of temporal and spatial distribution of probabilistic of the relevant parameters (rainfall, strong ground motion, human disturbance) with vulnerability and intensity/population of elements at risk for landslide risk assessments
	Early Warning and Real-Time Monitoring System (EW&RTM)
	• Establish correlation of antecedent rainfall data to landslide at different geographical zonings

Strategy 10.2	**Implement a national research and development programme**
	• Establish the appropriate threshold functions to earth slide, debris flow and rockfall for early warning purpose
	• Establish landslide movement models as predictive tool for failure with rapid slope movement and creeping slope movement
	• Explore seismic design for slopes and develop seismic induced landslide hazard map
	• Explore and incorporate the latest real time monitoring technology on landslide warning model
	• Compile historical landslide and rainfall records for each region
	Loss Assessment (LA)
	• Implement national research programme for loss assessment of area-based and linear-based projects in Malaysian context
	Public Awareness and Education (PAE)
	• Identify the "tolerable" and "acceptable" risk level for Malaysian for both urban and rural communities
	Loss Reduction Measures (LRM) *Design*
	• Harmonise existing planning guideline Existing planning guideline from Ikram, JKR, MPAJ and JMG shall be harmonized for consistent implementation
	• Review, revise and propose necessary policies on hillside development and management for slope engineering
	• Produce technical documents and guidelines on slopes design, strengthening measures and maintenance for design consultant
	• Produce economical and reliable engineering solutions and develop new codes and guidelines
	• Develop guideline on modules for planning and interpretation of subsurface investigation (SI) works
	• Develop guideline to enforce and improve supervision of SI works

Strategy 10.2	**Implement a national research and development programme**
	Maintenance • Setup and enforce the usage of maintenance guidelines for landslide risk management
	Mitigation Measures • Develop effective methods for landslide mitigation The method shall be effective and economical for evaluating and retrofitting, existing hazardous settlement or infrastructures which are subjected to natural and man-made landslide.
	Emergency Preparedness, Response and Recovery (EPRR)
	• Develop post-incident analysis model of landslide for improvement of emergency management of landslides
	• Develop usage of geotechnical instrumentation to timely monitor slope movement for safety of rescue personnel

**For the complete list of proposed R&D programme, refer to Appendix*

10.4.4 Summary

Table 10.12 : Action Plans

Strategy	Action Plans
Strategy 10.1 Develop a national research and development framework and multi-year implementation plan	10.1.1 Develop federal-state and public-private programmes to delineate landslide prone areas, to forecast the potential for landslides and to mitigate losses 10.1.2 Assign, coordinate, collaborate and disseminate all research from the universities and industries to facilitate capacity building for local researches 10.1.3 Set up a research network for quarterly review, practitioner feedback and peer evaluation 10.1.4 Set up research and training institution

Strategy 10.2 Implement national research and development programme	10.2.1 Implement a national research programme on slope engineering 10.2.2 Implement a national research programme on applied research that are directly usable by the practitioners

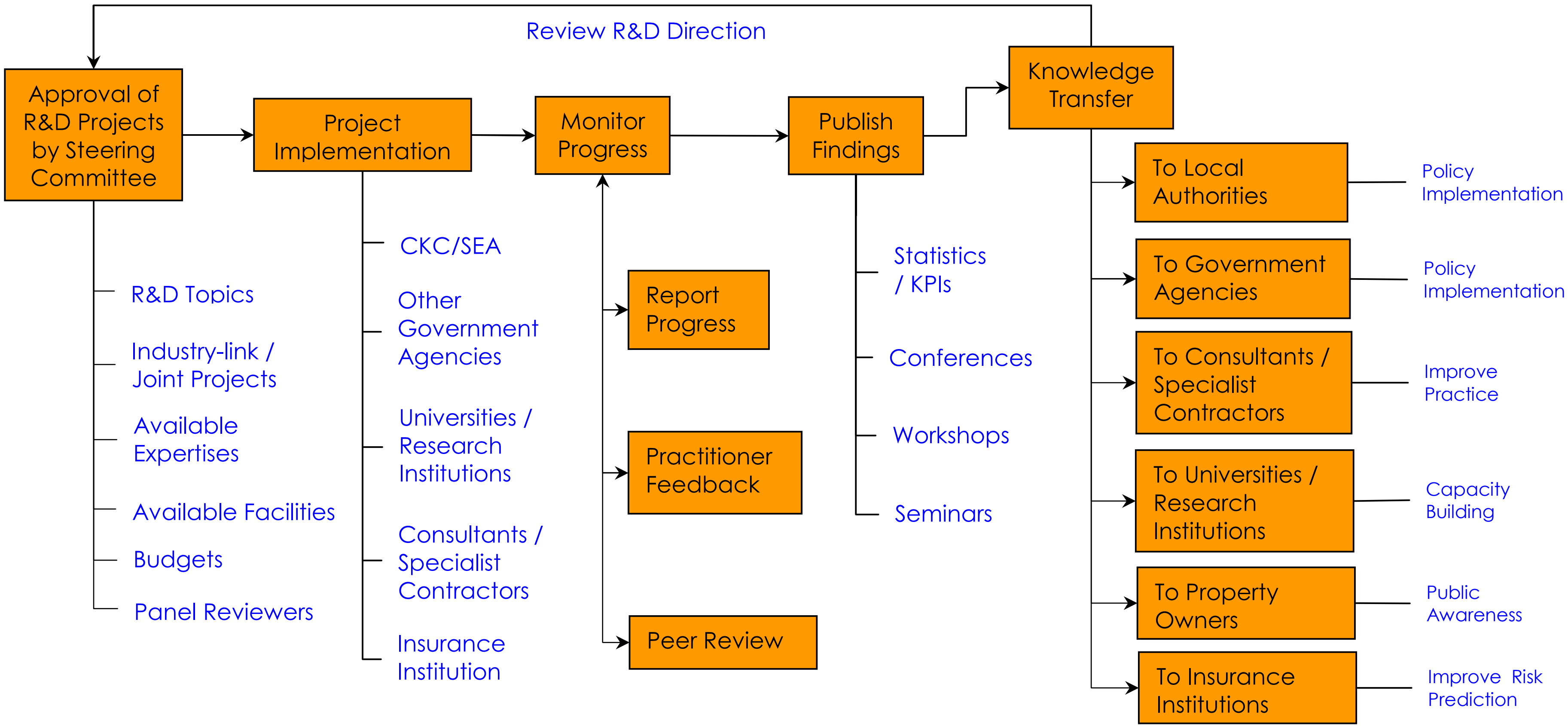
10.5 Implementation Framework and Plan

10.5.1 Introduction

For the success of landslide mitigation within the Master Plan in an effective and sustainable manner, all proposed strategies and action plans will only be attainable with the existence of a comprehensive implementation plan. As such, the following subsections have illustrated the proposed implementation process and implementation structure.

10.5.2 Implementation Process

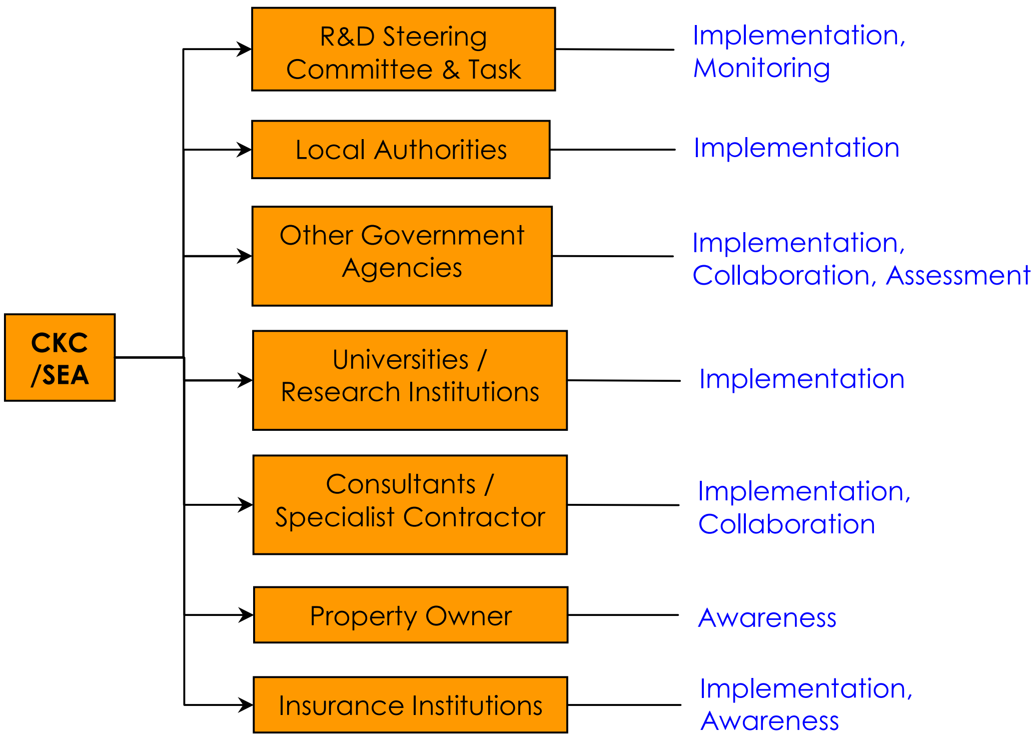
Figure 10.5 : Flow chart for implementation process



10.5.3 Implementation Structure

The following implementation structure describes the structure of anticipated involvement by all stakeholders for the success of the Master Plan.

Figure 10.6 : Implementation structure



10.5.4 Strategy Implementation Framework

Based on the strategies recommended in **section 10.4**, the proposed timeframe for the execution of all strategies and action plans has been represented graphically in **Table 10.13** and **Table 10.14**.

Table 10.13 : Strategy Implementation Framework

	2009	2010	2011	2012	2013	2014	2025	2016	2017	2018	2019	2020	2021	2022	2023
	Phase 1					Phase 2					Phase 3				
10.1 Develop a national research and development framework and multi-year implementation plan															
10.2 Implement national research and development programme															

10.5.5 Implementation of Action Plan

The Master Plan shall be implemented in three phases (i.e. short, medium and long term), each spanning a period of five years. Prior to implementation, there shall be a preparatory stage which is deemed to be a pre requisite to the subsequent implementation of the Master Plan. Furthermore, due to the shortcomings of the current slope engineering and slope management system, some proposed R&D topics are of top priority which shall be completed immediately (i.e. 2009-2010) upon setting up of CKC/SEA. Review on the effectiveness of the plan implementation shall be carried out at every phase for necessary correction and revision of the plan.

Table 10.14 : Implementation of Action Plan

No.	Action Plan	Who	When/Cost (RM Millions)**			
			Phase 1		Phase 2	Phase 3
			(2009 – 2010)	(2011 – 2013	(2014 – 2018)	(2019 – 2023)
10.1	**Develop a national research and development framework and multi-year implementation plan**					
10.1.1	Develop federal-state and public-private programmes to delineate landslide-prone areas to forecast the potential for landslides and to mitigate losses	CKC/SEA, JMG	0.4		0.4	0.4
10.1.2	Assign, coordinate, collaborate and disseminate all research from the universities and industries to facilitate	CKC/SEA	1.0		1.1	1.1

No.	Action Plan	Who	When/Cost (RM Millions)**			
			Phase 1		Phase 2	Phase 3
			(2009 – 2010)	(2011 – 2013	(2014 – 2018)	(2019 – 2023)
	capacity building for local research					
10.1.3	Set up a research network for quarterly review, practitioner feedback and peer evaluation	CKC/SEA /COE /Reviewer	0.4		0.4	0.4
10.1.4	Set up a research and training institute	CKC/SEA				1.5
10.2	**Implement a national research and development programme**					
10.2.1	Implement a national research programme for fundamental slope engineering	CKC/SEA /COE	2.6	3.6	8.1	5.0
10.2.2	Implement a national research programme on applied research that is directly usable by the practitioners	CKC/SEA /COE	5.9	6.0	10.0	15.7
		Subtotal	**19.9**		**20.0**	**24.1**
		Total	**64.0**			

Note:
* Estimated cost in addition to the operational cost of R&D unit
** The above costing has considered annual inflation rate of 6 percent

10.5.6 Critical Success Factors

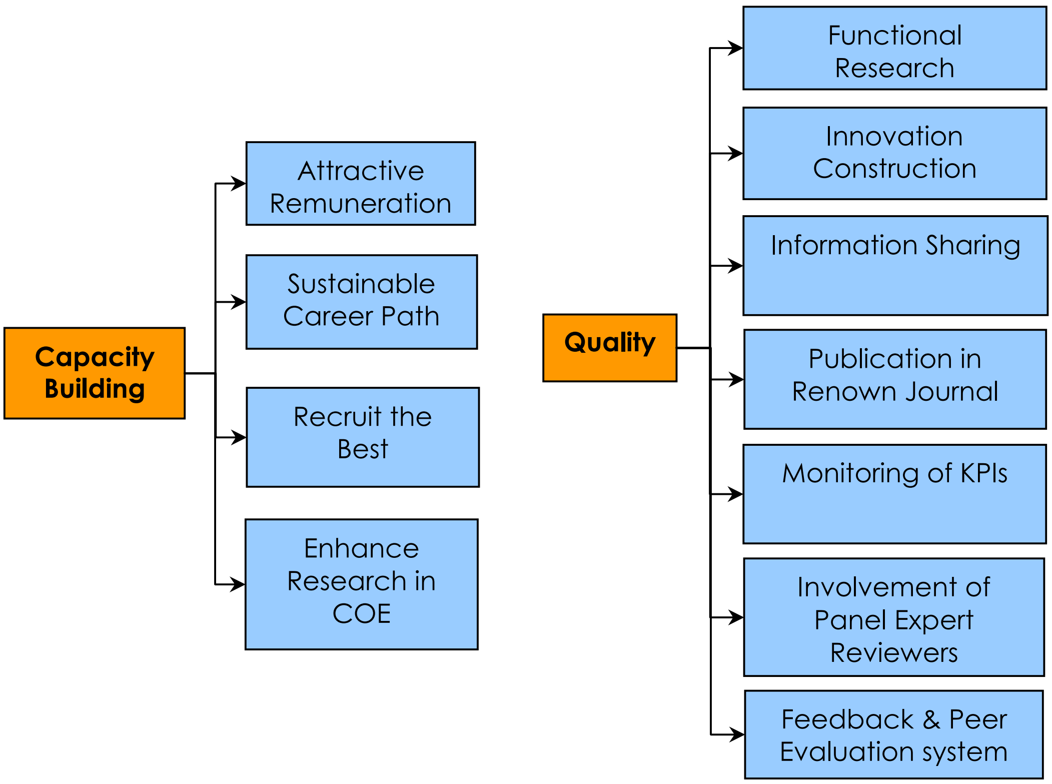
Critical success factors are the elements that are imperative to the success of the achievement of the strategy thrust, strategies, action plans and ultimately the improvement of mitigation measures and prediction capability. It is crucial for CKC/SEA to closely monitor the critical success factors and the Key Performance indicators (KPIs), and be single-mindedness in the implementation of the Master Plan.

Table 10.15 : Critical Success Factors

Critical Success Factors	Description
Capacity Building	Human capital is the most valuable asset in the success of the Master Plan. The keys to retaining good researchers are offering attractive remuneration, a sustainable career path and adopting a recruit-the-best policy. On the hardware aspect, collaboration with existing research centres to further enhance their value in slope related research and establishment of new centre of excellence (COE) to facilitate R&D activities not presently available would be deemed appropriate with the intention of not overlapping within the realm of R&D works. Therefore, the plan aims to improve and enhance the capacity of the nation in handling issues on slope engineering and slope management.
Quality	The Master Plan has proposed a list of R&D agenda for the implementation in 15 years. However, the quality of research will govern its functionality and benefits to the users. Therefore, a series of monitoring mechanism is set up to ensure the involvement of local and international experts as panel reviewers in the monitoring, feedback and peer evaluation system. As part of the key performance indicator, a quality journal paper shall be produced at the completion of project. The R&D findings should target for publication in renown international journal like *Géotechnique*, Canadian Geotechnical Journal, Journal of Asian Earth Sciences and International Journal of Rock Mechanics. Information sharing and knowledge transfer from R&D findings to practitioner is vital in the success of the Master Plan. This is to ensure continuous improvement in the implementation policies while allowing innovative construction techniques to be adopted for the benefit of the industry. A list of the R&D agenda has been identified for all aspects of slope engineering and slope management, ranging from those required for the development of policies, guidelines and the National Codes, to those needed

Critical Success Factors	Description
	for the development of Susceptibility, Hazard & Risk Maps. Therefore, it is essential to produce, revise and update the relevant tools for effective landslide mitigation at high risk areas.

Figure 10.7 : Summary of critical success factors



10.5.7 Key Performance Indicators

Key performance indicators (KPIs) are the most important statistics for the justification of CKC/SEA's performance and its existence. Therefore, and achievable target has been set for the future monitoring of the Master Plan in term of R&D advancement. CKC/SEA shall target a two-step process of loss reduction in landslide incidents with the aim to minimise the economical impact of landslides toward the nation. With inevitable population growth in the future, it is expected that landslide-induced losses will grow proportionately with the population growth if no control on slope management is imposed. It is important to establish the baseline for the current status of loss in relation to landslides and substantiate with the improvement of such baseline after the establishment of CKC/SEA. As total elimination of landslide incidents is near impossible, CKC/SEA shall emphasize on improvements in managing and controlling landslide risk as follows: The first step shall be containing the landslide risk with appropriate administrative control over new and old slopes. The second step would be improving risk reduction by retrofitting the existing slopes with high risk.

Similarly, the key performance index shall be applied to R&D activities. The target of achievement of R&D activities is summarized in **Table 10.16**. A performance assessment based on appropriate weighing factors over the corresponding critical success factors can be devised for the committed goal of CKC/SEA management. It is strongly recommended that CKC/SEA shall target for ISO certification.

Table 10.16 : Key performance indicators

Critical Success Factors	Key Performance Indicators	Target		
		Phase 1	Phase 2	Phase 3
Capacity Building Emphasise on the capacity and capability of researchers and practitioners in R&D works	• Number of projects completed by each centre of excellence	80% of proposed Phase 1 R&D agenda	80% of proposed Phase 2 R&D agenda	80% of proposed Phase 3 R&D agenda
Quality Emphasise on the quality of R&D findings and its contribution towards the slope management and engineering field	• Number of international journal papers produced per phase	10	20	30

* Improvements will be computed from base year 2008

Expected Outcome

The expected outcome of the NSMP on R&D are divided three phases:

Phase 1

(2008-2009): Setting-up of all necessary implementation mechanism inclusive of a system for project assignment, project reviewing, budget allocation and implementation of urgent R&D projects.

(2010-2012): Rationalised and standardised implementation guidelines and policies for hillside developments. Based on R&D findings on landslide causes and triggering factors as well as failure mechanism in the Malaysian context, design guidelines and templates for hillside developments are developed.

Phase 2 (2013-2017): Updated and refined implementation policies, design guidelines and templates for hillside development and R&D findings on landslide susceptibility, hazard, vulnerability and risk.

Phase 3 (2018-2022): Continuously updated and refined implementation policies, design guidelines and templates for hillside developments, especially through R&D findings on optimum mitigation solutions with consideration of environmental aspects.

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APPENDIX 1

TECHNICAL TERMS AND LIST OF MAJOR LANDSLIDES

I) GLOSSARY

The ISDR Secretariat presents these basic definitions on disaster risk reduction in order to promote a common understanding on this subject, for use by the public, authorities and practitioners. The terms are based on a broad consideration of different international sources (*source: www.unisdr.org*).

Keyword	Description
Acceptable risk	The level of loss a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions. *In engineering terms, acceptable risk is also used to assess structural and non-structural measures undertaken to reduce possible damage at a level which does not harm people and property, according to codes or "accepted practice" based, among other issues, on a known probability of hazard.*
Building codes	Ordinances and regulations controlling the design, construction, materials, alteration and occupancy of any structure to insure human safety and welfare. Building codes include both technical and functional standards.
Capacity	A combination of all the strengths and resources available within a community, society or organization that can reduce the level of risk, or the effects of a disaster. *Capacity may include physical, institutional, social or economic means as well as skilled personal or collective attributes such as leadership and management. Capacity may also be described as capability.*
Capacity building	Efforts aimed to develop human skills or societal infrastructures within a community or organization needed to reduce the level of risk. *In extended understanding, capacity building also includes development of institutional, financial, political and other resources, such as technology at different levels and sectors of the society.*
Climate change	The climate of a place or region is changed if over an extended period (typically decades or longer) there is a statistically significant change in measurements of either the mean state or variability of the climate for that place or region. *Changes in climate may be due to natural processes or to persistent anthropogenic changes in atmosphere or in land use. Note that the definition of climate change used in the United Nations Framework Convention on Climate Change is more restricted, as it includes only those changes which are attributable directly or indirectly to human activity.*
Coping capacity	The means by which people or organizations use available resources and abilities to face adverse consequences that could lead to a disaster. *In general, this involves managing resources, both in normal times as well as during crises or adverse conditions. The strengthening of coping capacities usually builds resilience to withstand the effects of natural and human-induced hazards.*
Counter measures	All measures taken to counter and reduce disaster risk. They most commonly refer to engineering (structural) measures but can also include non-structural measures and tools designed and employed to avoid or limit the adverse impact of natural hazards and related environmental and technological disasters.
Disaster	A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources. *A disaster is a function of the risk process. It results from the combination of hazards, conditions of vulnerability and insufficient capacity or measures to reduce the potential negative consequences of risk.*
Disaster risk management	The systematic process of using administrative decisions, organization, operational skills and capacities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural hazards and related environmental and technological disasters. This comprises all forms of activities, including structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of hazards.

Disaster risk reduction (disaster reduction)

The conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development.

Early warning

The provision of timely and effective information, through identified institutions, that allows individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response.

Early warning systems include a chain of concerns, namely: understanding and mapping the hazard; monitoring and forecasting impending events; processing and disseminating understandable warnings to political authorities and the population, and undertaking appropriate and timely actions in response to the warnings.

El Niño-southern oscillation (ENSO)

A complex interaction of the tropical Pacific Ocean and the global atmosphere that results in irregularly occurring episodes of changed ocean and weather patterns in many parts of the world, often with significant impacts, such as altered marine habitats, rainfall changes, floods, droughts, and changes in storm patterns.

The El Niño part of ENSO refers to the well-above-average ocean temperatures along the coasts of Ecuador, Peru and northern Chile and across the eastern equatorial Pacific Ocean, while the Southern Oscillation refers to the associated global patterns of changed atmospheric pressure and rainfall. La Niña is approximately the opposite condition to El Niño. Each El Niño or La Niña episode usually lasts for several seasons.

Emergency management

The organization and management of resources and responsibilities for dealing with all aspects of emergencies, in particularly preparedness, response and rehabilitation.

Emergency management involves plans, structures and arrangements established to engage the normal endeavours of government, voluntary and private agencies in a comprehensive and coordinated way to respond to the whole spectrum of emergency needs. This is also known as disaster management.

Environmental impact assessment (EIA)

Studies undertaken in order to assess the effect on a specified environment of the introduction of any new factor, which may upset the current ecological balance.

EIA is a policy making tool that serves to provide evidence and analysis of environmental impacts of activities from conception to decision-making. It is utilised extensively in national programming and for international development assistance projects. An EIA must include a detailed risk assessment and provide alternatives solutions or options.

Environmental degradation

The reduction of the capacity of the environment to meet social and ecological objectives, and needs.

Potential effects are varied and may contribute to an increase in vulnerability and the frequency and intensity of natural hazards.

Some examples: land degradation, deforestation, desertification, wildland fires, loss of biodiversity, land, water and air pollution, climate change, sea level rise and ozone depletion.

Forecast

Definite statement or statistical estimate of the occurrence of a future event (UNESCO, WMO).

Geological hazard

Natural earth processes or phenomena that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

Geological hazard includes internal earth processes or tectonic origin, such as earthquakes, geological fault activity, tsunamis, volcanic activity and emissions as well as external processes such as mass movements: landslides, rockslides, rock falls or avalanches, surfaces collapses, expansive soils and debris or mud flows.

Geological hazards can be single, sequential or combined in their origin and effects.

Geographic information systems (GIS)

Analysis that combine relational databases with spatial interpretation and outputs often in form of maps. A more elaborate definition is that of computer programmers for capturing, storing, checking, integrating, analyzing and displaying data about the earth that is spatially referenced.

Geographical information systems are increasingly being utilized for hazard and vulnerability mapping and analysis, as well as for the application of disaster risk management measures.

Greenhouse gas (GHG)

A gas, such as water vapour, carbon dioxide, methane, chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), that absorbs and re-emits infrared radiation, warming the earth's surface and contributing to climate change (UNEP, 1998).

Hazard	A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. *Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydrometeorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterised by its location, intensity, frequency and probability.*
Hazard analysis	Identification, studies and monitoring of any hazard to determine its potential, origin, characteristics and behaviour.
Hydrometeo-rological hazards	Natural processes or phenomena of atmospheric, hydrological or oceanographic nature, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. *Hydrometeorological hazards include: floods, debris and mud floods; tropical cyclones, storm surges, thunder/hailstorms, rain and wind storms, blizzards and other severe storms; drought, desertification, wildland fires, temperature extremes, sand or dust storms; permafrost and snow or ice avalanches. Hydrometeorological hazards can be single, sequential or combined in their origin and effects.*
La Niña	(see El Niño-Southern Oscillation).
Land-use planning	Branch of physical and socio-economic planning that determines the means and assesses the values or limitations of various options in which land is to be utilized, with the corresponding effects on different segments of the population or interests of a community taken into account in resulting decisions. *Land-use planning involves studies and mapping, analysis of environmental and hazard data, formulation of alternative land-use decisions and design of a long-range plan for different geographical and administrative scales.* *Land-use planning can help to mitigate disasters and reduce risks by discouraging high-density settlements and construction of key installations in hazard-prone areas, control of population density and expansion, and in the siting of service routes for transport, power, water, sewage and other critical facilities.*
Mitigation	Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards.
Natural hazards	Natural processes or phenomena occurring in the biosphere that may constitute a damaging event. *Natural hazards can be classified by origin namely: geological, hydrometeorological or biological. Hazardous events can vary in magnitude or intensity, frequency, duration, area of extent, speed of onset, spatial dispersion and temporal spacing.*
Nowcasting	The detailed description of the current weather along with forecasts obtained by extrapolation up to about 2 hours ahead. Any area-specific forecast for the period up to 12 hours ahead that is based on very detailed observational data. *(Additional definition to ISDR's basic definitions)*
Preparedness	Activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warnings and the temporary evacuation of people and property from threatened locations.
Prevention	Activities to provide outright avoidance of the adverse impact of hazards and means to minimize related environmental, technological and biological disasters. *Depending on social and technical feasibility and cost/benefit considerations, investing in preventive measures is justified in areas frequently affected by disasters. In the context of public awareness and education, related to disaster risk reduction changing attitudes and behaviour contribute to promoting a "culture of prevention".*
Public awareness	The processes of informing the general population, increasing levels of consciousness about risks and how people can act to reduce their exposure to hazards. This is particularly important for public officials in fulfilling their responsibilities to save lives and property in the event of a disaster. *Public awareness activities foster changes in behaviour leading towards a culture of risk reduction. This involves public information, dissemination, education, radio or television broadcasts, use of printed media, as well as, the establishment of information centres and networks and community and participation actions.*
Public information	Information, facts and knowledge provided or learned as a result of research or study, available to be disseminated to the public.

Recovery	Decisions and actions taken after a disaster with a view to restoring or improving the pre-disaster living conditions of the stricken community, while encouraging and facilitating necessary adjustments to reduce disaster risk. *Recovery (rehabilitation and reconstruction) affords an opportunity to develop and apply disaster risk reduction measures.*
Relief / response	The provision of assistance or intervention during or immediately after a disaster to meet the life preservation and basic subsistence needs of those people affected. It can be of an immediate, short-term, or protracted duration.
Resilience / resilient	The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures.
Retrofitting (or upgrading)	Reinforcement of structures to become more resistant and resilient to the forces of natural hazards. *Retrofitting involves consideration of changes in the mass, stiffness, damping, load path and ductility of materials, as well as radical changes such as the introduction of energy absorbing dampers and base isolation systems. Examples of retrofitting includes the consideration of wind loading to strengthen and minimize the wind force, or in earthquake prone areas, the strengthening of structures.*
Risk	The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions. *Conventionally risk is expressed by the notation* *Risk = Hazards x Vulnerability. Some disciplines also include the concept of exposure to refer particularly to the physical aspects of vulnerability.* *Beyond expressing a possibility of physical harm, it is crucial to recognize that risks are inherent or can be created or exist within social systems. It is important to consider the social contexts in which risks occur and that people therefore do not necessarily share the same perceptions of risk and their underlying causes.*
Risk assessment /analysis	A methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend. *The process of conducting a risk assessment is based on a review of both the technical features of hazards such as their location, intensity, frequency and probability; and also the analysis of the physical, social, economic and environmental dimensions of vulnerability and exposure, while taking particular account of the coping capabilities pertinent to the risk scenarios.*
Structural / non-structural measures	Structural measures refer to any physical construction to reduce or avoid possible impacts of hazards, which include engineering measures and construction of hazard-resistant and protective structures and infrastructure. *Non-structural measures refer to policies, awareness, knowledge development, public commitment, and methods and operating practices, including participatory mechanisms and the provision of information, which can reduce risk and related impacts.*
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs. (Brundtland Commission, 1987). *Sustainable development is based on socio-cultural development, political stability and decorum, economic growth and ecosystem protection, which all relate to disaster risk reduction.*
Vulnerability	The conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards. *For positive factors, which increase the ability of people to cope with hazards, see definition of capacity.*

II) DESCRIPTION OF LANDSLIDE FEATURES

The morphology of landslide were first described by Cruden & Varnes (1996) and are presented in Figure 1.

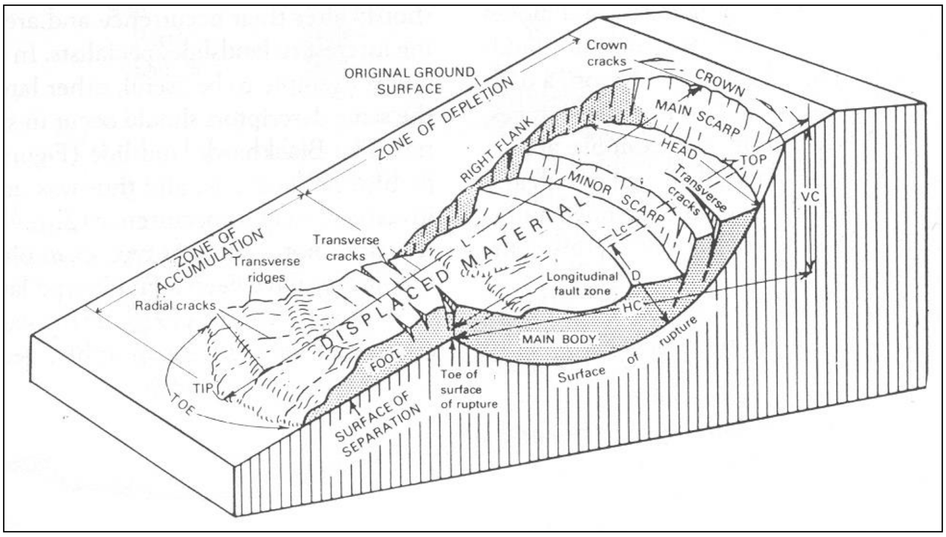
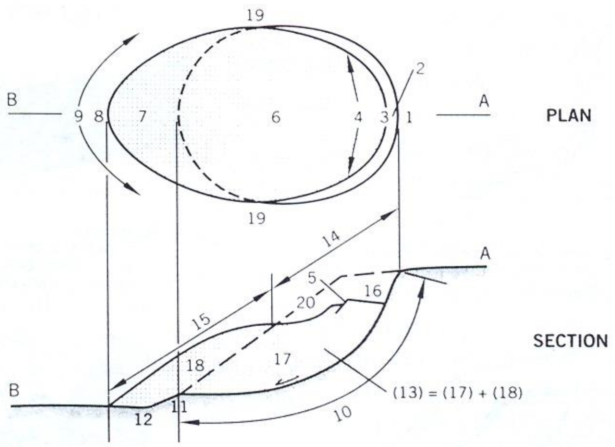


Figure 1: Terminology for Describing Landslide Features (Cruden & Varnes, 1996)

However, the International Association of Engineering Geologists (IAEG) created a Commission on Landslides that has subsequently made minor modifications and was reproduced in Figure 2. As can be seen from Figure 2, the elevation of the ground surface decreases as a result of landsliding in the *zone of depletion* while the elevation of the ground surface increases in the *zone of accumulation* (Cornforth, 2005).



No.	Name	Definition
1	Crown	Practically undisplaced material adjacent to highest parts of main scarp
2	Main scarp	Steep surface on undisturbed ground at upper edge of landslide caused by movement of displaced material (13, stippled area) away from undisturbed ground; it is a visible part of surface of rupture (10)
3	Top	Highest point of contact between displaced material (13) and main scarp (2)
4	Head	Upper parts of landslide along contact between displaced material and main scarp (2)
5	Minor scarp	Steep surface on displaced material of landslide produced by differential movements within displaced material
6	Main body	Part of displaced material of landslide that overlies surface of rupture between main scarp (2) and toe of surface of rupture (11)
7	Foot	Portion of landslide that has moved beyond toe of surface of rupture (11) and overlies original ground surface (20)
8	Tip	Point on toe (9) farthest from top (3) of landslide
9	Toe	Lower, usually curved margin of displaced material of a landslide, most distant from main scarp (2)
10	Surface of rupture	Surface that forms (or that has formed) lower boundary of displaced material (13) below original ground surface (20); also termed *slip surface* or *shear surface*; if planar, can be termed *slip plane* or *shear plane*
11	Toe of surface of rupture	Intersection (usually buried) between lower part of surface of rupture (10) of a landslide and original ground surface (20)
12	Surface of separation	Part of original ground surface (20) now overlain by foot (7) of landslide
13	Displaced material	Material displaced from its original position on slope by movement in landslide; comprises both depleted mass (17) and accumulation (18)
14	Zone of depletion	Area of landslide within which displaced material lies below original ground surface (20)
15	Zone of accumulation	Area of landslide within which displaced material (13) lies above original ground surface (20)
16	Depletion	Volume bounded by main scarp (2), depleted mass (17), and original ground surface (20)
17	Depleted mass	Volume of displaced material (13) that overlies surface of rupture (10) but underlies original ground surface (20)
18	Accumulation	Volume of displaced material (13) that lies above original ground surface (20)
19	Flank	Undisplaced material adjacent to sides of surface of rupture; if left and right are used, they refer to flanks as viewed from crown; otherwise use compass directions
20	Original ground surface	Surface of slope that existed before landslide took place

Figure 2: Description of Landslide Features (based on UNESCO Working Party,1993, with minor modifications) (Cornforth, 2005)

III) LANDSLIDE CLASSIFICATION

- **Type of Slope**

  - Natural Slope
  - Man-made Slope

- **Type of material**

  - Rock
  - Predominantly coarse material (debris): Material defined as having 20%-80% of particles in the gravel/boulder size (>2mm) (Huat et. al., 2008)
  - Predominantly fine material (earth)

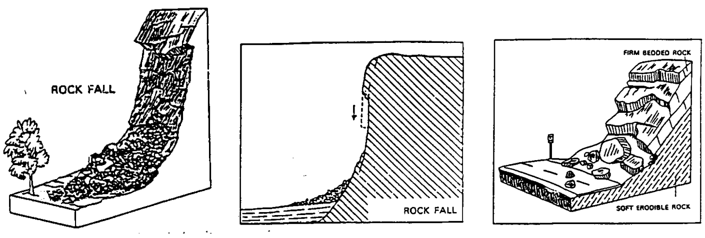
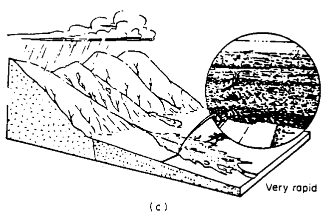
- **Type of Movement**

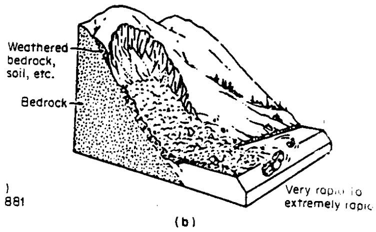
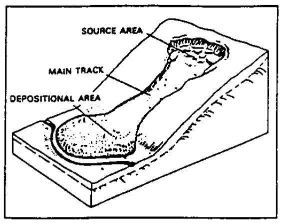
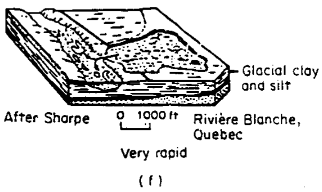
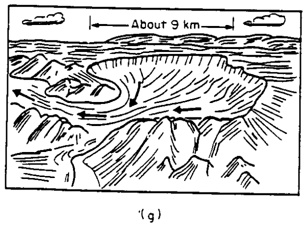
  In the original work by Varnes (1978), Varnes had generally categorized the landslide movement as follows:
  - Falls
  - Topples
  - Slides – rotational and translational
  - Lateral Spreads
  - Flows
  - Combination of types

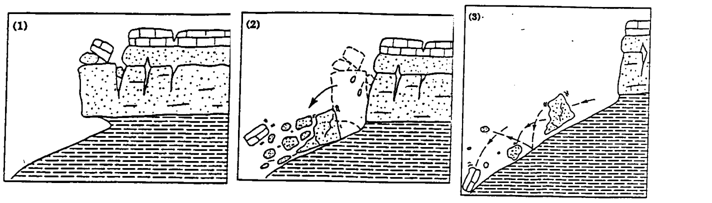
  The category was later updated and being further categorized by Hunt (1984) and Cruden & Varnes (1996).

Table 1: Type of Landslides Movement

(compiled and modified from Hunt (1984), Cruden & Varnes (1996))

Type Of Movement	Description	Examples
FALLS	Falls are abrupt movements of masses of geologic materials that become detached from steep slopes or cliffs (i.e., rock fall). Movement occurs by free fall, bouncing and rolling. Depending on the type of earth materials involved, the result is a rock fall, soil fall, debris fall, earth fall, boulder fall and so on. All types of falls are promoted by undercutting, differential weathering, excavation or stream erosion.	
FALLS (Debris Flow)	A debris flow is a form of rapid mass movement in which loose soils, rocks and organic matter combined with entrapped air and water to form a slurry that then flows down-slope. Debris flow areas are usually associated with steep gullies. Individual debris flow areas can usually be identified by the presence of debris fans at the termini of the drainage basins.	

FALLS (Debris Avalanche)	A variety of very rapid to extremely rapid debris flow	
FALLS (Earth Flow)	Earth flows have a characteristic “hour glass” shape. A bowl of depression forms at the head where the unstable material collects and flows out. The central area is narrow and usually becomes wider as it reaches the valley floor. Flows generally occur in fine-grained materials clay-bearing rocks on moderate slopes and with saturated conditions. However, dry flows of granular material are also possible.	
FALLS (Mud Flow)	An earth flow that consists of material that is wet enough to flow rapidly and that contains at least 50% sand, silt- and clay- sized particles.	
FALLS (Lahar)	A mud flow or debris flow that originates on a slope of a volcano. Lahars are usually triggered by such things as heavy rainfall eroding volcanic deposits; sudden melting of snow and ice due to heat from volcanic vents; or by the breakout of water from glaciers, crater lakes, or lakes dammed by volcanic eruptions.	
FALLS (STURZSTROM / Rock Avalanche)	A sturzstrom is caused by a trigger, such as an earthquake or volcano. It moves rapidly, but does not necessarily require water to be present within it to move. Therefore, there is no definite explanation for their movement. The leading theory is that sturzstroms ride on "air cushions", or dust clouds generated by itself. This is called acoustic fluidization. Once moving, it can ride over nearly any terrain. It more often moves over horizontal ground, more than downward-sloped ground. Its momentum can carry it up small hills. Some characteristics of sturzstroms are: ▪ Mass movement of dry rock debris. ▪ Avalanche volume > about 106 cubic meters. ▪ Ratio of fall height to run out length < 0.6. ▪ Mobility of sturzstroms increases with avalanche volume. ▪ Observations suggest sturzstroms "flow" like a fluid *(source: www.en.wikipedia.org)*	

<table>
<tr>
<td>TOPPLES</td>
<td>A topple is a block of rock that tilts or rotates forward on a pivot or hinge point and then separates from the main mass, falling to the slope below, and subsequently bouncing or rolling down the slope.</td>
<td>
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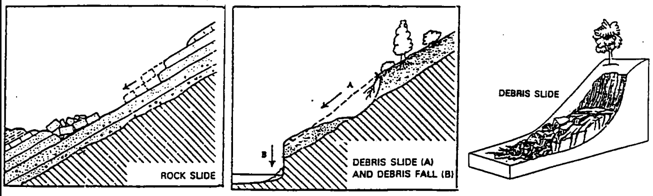
<td>SLIDES</td>
<td>A more restrictive use of the term which refers to movements of soil or rock along a distinct surface of rupture which separates the slide material from more stable underlying material. The 2 major types of landslides are rotational slides and translational slides.</td>
<td>
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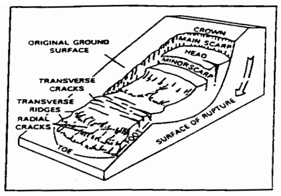
<tr>
<td>SLIDES
(Rotational)</td>
<td>One in which the surface of rupture is curved concavely upwards (spoon shaped) and the slide

movement is more or less rotational about the axis that is parallel to the contour of the slope. “Slump” is an example of a small rotational slide.</td>
<td>
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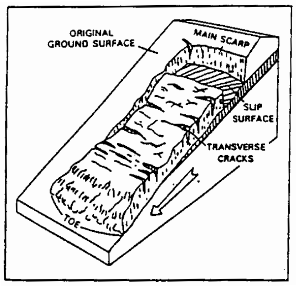
<tr>
<td>SLIDES
(Translational)</td>
<td>The mass moves out, or down and outwards along a relatively planar surface and has little rotational movement or backward tilting. The mass commonly slides out on top of the original ground surface. Such a slide may progress over great distances if conditions are right. Slide material may range from loose unconsolidated soils to extensive slabs of rock. A “block slide” is a translational slide in which the moving mass consists of a single unit, or a few closely related units that move down-slope as a single unit.</td>
<td>
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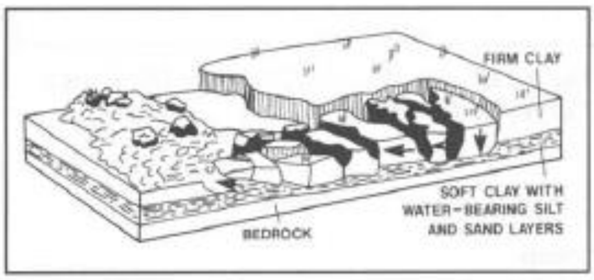
<tr>
<td>LATERAL SPREADS</td>
<td>A result of a nearly horizontal movement of geologic materials and are distinctive because they usually occur on very gentle slopes. The failure is caused by liquefaction, the process whereby saturated, loose, cohesionless sediments (usually sands & silts) are transformed from a solid into a liquefied state. Failure usually triggered by rapid ground motion such as that experienced during earthquake, or by slow chemical changes in the pore water and mineral constituents.</td>
<td>
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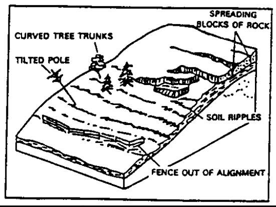
<tr>
<td>FLOWS
(Creep)</td>
<td>This is the imperceptibly slow, steady downward movement of slope-forming soil and rock. Creep is indicated by curved tree trunks, bent fences or retaining walls, tilted poles or fences, and small soil ripples or terracettes.</td>
<td>
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- **Disturbance State of Slope Material (Huat et. al., 2008)**
  - Virgin Landslides: Occur in undisturbed slope materials operating with mobilized peak soil strength.
  - Reactivated Landslides: Occur in disturbed slope materials at a previous landslip area operating with mobilized residual shear strength.

- **Rate of Movement**

Table 2: Velocity Classes for Landslides (after International Geotechnical Societies UNESCO Working Parrty on World Landslide Inventory (WP/WLI, 1995)

Velocity Class	Description	Velocity Limit	Nature of Impact
7	**Extremely Rapid**	5 m/s	Catastrophe of major violence, exposed buildings totally destroyed and population killed by impact of displaced material, or by disaggregation of the displaced mass
6	**Very Rapid**	3 m/min	Some lives lost because the landslide velocity is too great to permit all persons to escape, major destruction
5	**Rapid**	1.8 m/hour	Escape and evacuation possible; structure, possessions and equipment destroyed by the displaced mass
4	**Moderate**	13 m/month	Insensitive structures can be maintained if they are located a short distance in front of the toe of the displaced mass; structures located on the displaced mass are extensively damaged
3	**Slow**	1.6 m/year	Roads and insensitive structures can be maintained with frequent and heavy maintenance work, if the movement does not last too long and if differential movements at the margins of the landslide are distributed across a wide zone
2	**Very Slow**	0.016 m/ year	Some permanent structures undamaged or, if they are cracked by the movement, they can be repaired
1	**Extremely Slow**		No damage to structures built with precautions

In addition, very slow or extremely slow slope movements are often termed as creep

- **Size**

Up to date, there is no available standard to categorize the landslide by size. However, it is relatively useful to provide some guidelines to describe the extent of a landslide. Cornforth (2005) suggested a guideline for such a purpose which is presented in Table 3.

Table 3: Classification of Landslides by Area in Plan (Cornforth, 2005)

Description	Area (sq.ft.)	Area (sq.m.)
Very Small	< 2000	**< 200**
Small	2,000 – 20,000	**200 – 2,000**
Medium	20,000 – 200,000	**2,000 – 20,000**
Large	200,000 – 2,000,000	**20,000 – 200,000**
Very Large	2,000,000 – 20,000,000	**200,000 – 2,000,000**
Huge	**> 20,000,000**	**> 2,000,000**

- **Drainage condition**

Table 4: Classification of Landslides by Drainage Condition (Huat et. al., 2008)

Drainage Condition	Description
Drained (long term)	No excess pore pressures are generated during shearing or they are fully dissipated
Partially drained (medium term)	Some excess pore pressures generated during shearing are partially dissipated
Undrained (short term)	Low permeability soils, excess pore pressures are generated during shearing

- **Style**

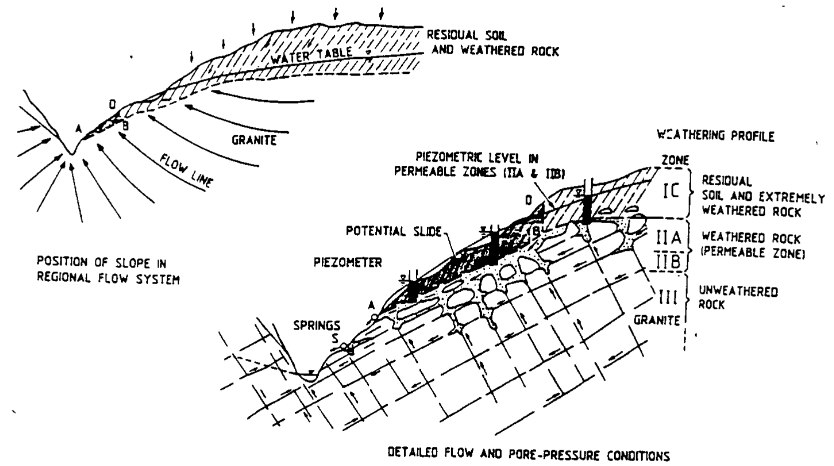
Landslides were classified as shallow or deep-seated because they generally present two distinct types of hazard. Most shallow landslides move downslope rapidly, and can mobilize into far reaching, life-threatening flow-type failures with addition of water at the source, or along the run out path, or when an advancing slide mass encounters a flowing stream. In contrast, deep-seated landslides such as rotational slumps, commonly move at a slower rate and cover a shorter distance. Thus, deep-seated landslides present a hazard primarily to the area on immediately surrounding the slide along the down slope, and some warning, such as the appearance of tension cracks at the crown or bulging at the toe, may precede significant landslide movement (Utah 2006)

Table 5: Classification of Landslides by Shallow or Deep-Seated Failure

Shallow Failure	o Depth to failure plane generally less than 10 feet - 3 m (Utah, 2006) o Depth to failure plane generally less than 4 feet – 1.2 m (Day, R. W., 2004) o Depth to failure surfaces lesser than 10m (Jaboyedoff et. al., 2004)
Deep-Seated Failure	o Depth to failure plane greater than 10 feet - 3 m (Utah 2006) o Depth to failure plane greater than 4 feet – 1.2 m (Day, R. W., 2004) o Depth to failure surfaces greater than 10m and large volume of material flow (i.e. 1,000,000 m^3) (Jaboyedoff et. al., 2004)

- **Geological environment**

Table 6 : Relationship between Geological Environment and Landslide (MacGregor et. al., (1990) and Stapledon (1992))

Granite	

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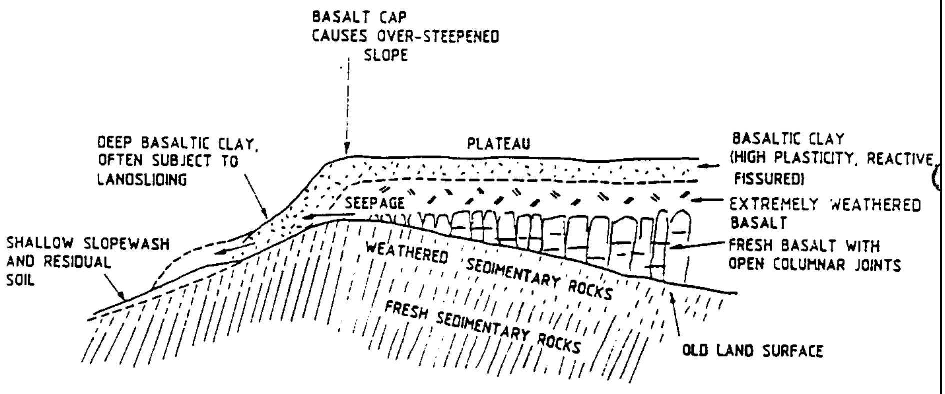
<tr><td>Volcanic</td><td>

Typical profile through margin of basalt plateau, showing conditions which lead to slope instability.</td></tr>
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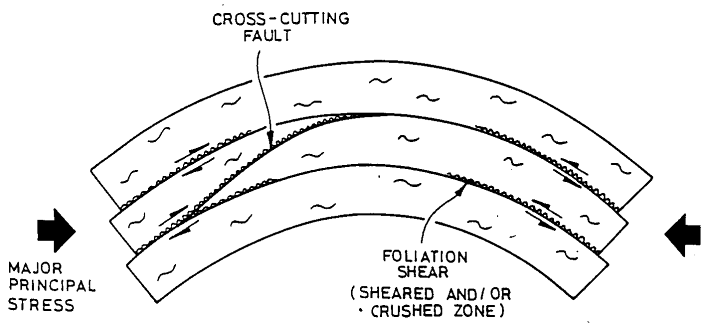
(eg. schist, slate, phyllite)</td><td>
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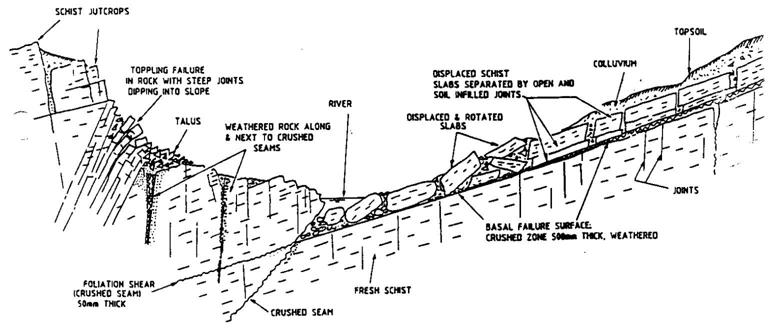
<tr><td>
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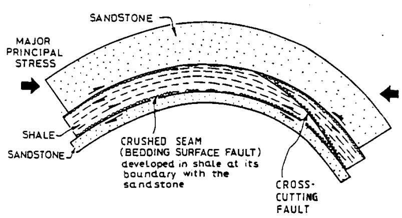
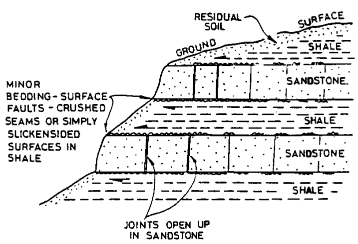
<tr><td>Mudrocks</td><td>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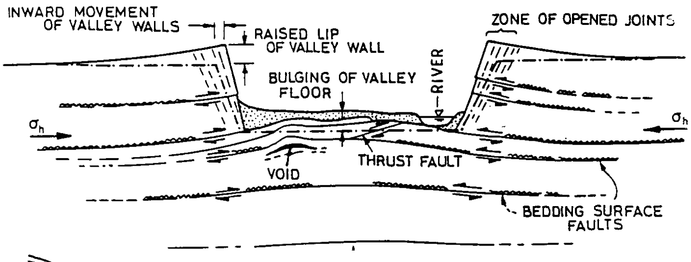
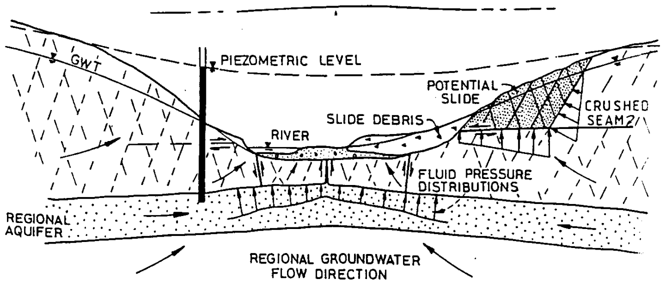
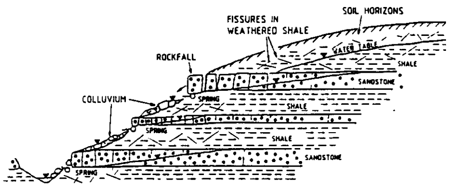
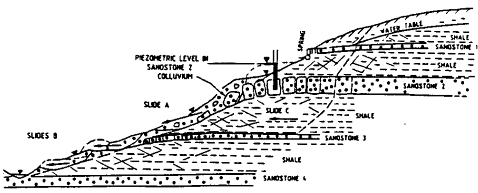
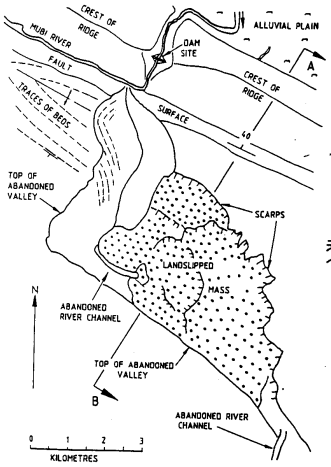
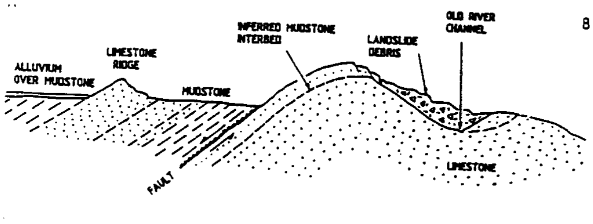
Sandstones, Siltstones, Conglomerates	   
Carbonate Rocks	 

IV) LANDSLIDE DATABASE IN MALAYSIA (TODATE)

Table6: Series of major landslide occurrences in Malaysia

No.	Date	Location	Type and Nature of Landslide/Slope Failure. Size/Volume	No. of Death	Notes	Main Causes/ Triggering Factors	Policy Impact	Rehabilitation Measures
1	Oct. 1993	Kuala Lipis-Gua Musang	Part of the road collapse due to failure of fill slope following a period of continuous rain	1	-	*	*	*
2	Nov. 1993	Karak Highway	Shallow rotational slide. Failure of cut slope at the side of the highway occurred at dawn - buried in motorcycle rider and its pillion	2	Cut slope in granitic formation	*	*	*
3	Dec. 1993	Ulu Klang, Selangor	Shallow rotational slide. Prolonged and heavy rain triggered retrogressive failure of cut slope behind the Highland Tower apartment - toppled Block A	48	Cut slope in granitic formation	Inadequate design, improper construction, triggered by rainfall	*	*
4	March 1994	Fraser Hill	Collapse of balconies of Fraser's Pine Resort due to landslide	-	Natural slope	*	*	*
5	June 1995	Karak Highway - Genting Highland slip road, Selangor – Pahang border	Debris flow. Failure of upstream natural dam during heavy rain triggered 'snowball effect' debris avalanche	22	Natural slope in meta-sediment formation	Triggered by heavy rainfall	*	*
6	Jan. 1996	Gunung Tempurung, Kampar, Perak	Deep-seated rotational slide. Failure of cut slope (strengthened by anchor and guniting) at the side of North-South Highway	1	Cut slope in granitic formation	Adverse geological, Triggered by rainfall	*	*
7	Aug. 1996	Orang Asli settlement, Post Dipang, Kampar, Perak	Debris flow from erosion and logging activities along upstream of Sungai Dipang occurred during heavy rain	44	Natural slope in granitic formation	Inadequate FOS Triggered by rainfall	*	*
8	Nov. 1998	Bukit Saujana, Paya Terubung, Penang	Massive rockslide	-	Cut slope in granitic formation	Inappropriate design , triggered by rainfall	*	*
9	Jan. 1999	Squatters settlement, Sandakan, Sabah	Shallow rotational slide. Heavy rain triggered landslide - buried a number of houses/huts	13	Natural slope in meta-sediment formation	Inadequate FOS, Triggered by rainfall	*	*

10	May 1999	Bukit Antarabang sa, Ulu Kelang	Massive landslide	-	-	Inadequate design, improper construction, triggered by prolonged rainfall	*	*
11	Jan. 2000	Vegetable farm, Cameron Highlands, Pahang	Debris flow from upstream landslide and erosion washed away workers squatters	6	Vegetable farm on sloping land in meta-sediment formation	*	*	*
12	Jan. 2001	Simunjan, Sarawak	Shallow rotational slide. Landslide occurred on vegetable farm - buried a number of houses at the toe of slope	16	Vegetable farm on sloping land in meta-sediment formation	*	*	*
13	Dec. 2001	Gunung Pulai, Johor	Debris flow. Heavy rain triggered debris flow resulting from a number of small landslides along upstream of Sungai Pulai - washed away settlements along the river bank	5	Natural slope in granitic formation	*	*	*
14	Nov. 2002	Hillview, Ulu Kelang, Selangor	Debris flow. Sliding/flowing of debris soil during heavy rain - toppled a bungalow at the toe of the hill	8	Dumping area of abandone d project in granitic formation	Inadequate design of the adjacent slope, triggered by rainfall, old landslide location	*	*
15	Oct. 2003	Gunung Raya Road, Langkawi	Deep-seated rotational slides. Landslide triggered by heavy and prolonged rain - buried a machine and its operator while clearing the debris.	1	Cut slope in granitic formation	*	*	*
16	Nov. 2003	Bukit Lanjan, North Klang Valley Expressway	Rock Slide/rock debris	-	Cut slope in granitic formation	Adverse geological condition, long term weathering , prolonged rainfall	*	*
17	Nov. 2004	Taman Harmonis, Gombak, Selangor	Debris flow. Sliding/flowing of debris soil from uphill bungalow project - toppled the back-portion of neighboring down slope bungalow after weeklong continuous rain.	1	Dumping area of ongoing project in meta-sediment formation		*	*

18	Dec. 2004	Bercham, Ipoh, Perak	Rock fall - buried back portion of illegal factory at the foot of limestone hill.	2	Natural limestone cliff in karsts formation	*	*	*
19	May 2006	Ulu Klang, Selangor	Landslide due to collapse of retaining wall and retrogressive slope failures. Buried 3 blocks of longhouses.	4	Cut slope in granitic residual soil. The area is also known to be highly susceptible to severe erosion	*	*	*
20	Oct. 2006	Wangsa Maju	Landslide to near the residential Flat Block B4 and Block B5.		Cut slope in granitic residual soil. The area is also known to be highly susceptible to severe erosion	Triggered by heavy rainfall	*	*
21	Oct. 2006	Jalan Sepanggar, Sabah	15 houses were crushed by mudslide*	1	The monsoon rains had loosened soil on hillsides*	Triggered by heavy rainfall *	*	*
22	March 2007	Presinct 9, Putrajaya	Landslide occurred on height hill slope at Taman Rimba Desa, which is also behind the phase 11 Apartments in Precinct 9, Putrajaya.	*	Cut Slopes in meta-sediment formation	Triggered by heavy rainfall	*	*

**Note :* - Still searching for information*

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Appendix 2

Summary of Proposed Research Agenda for All Modules of the Master Plan

Topics / Areas of Required R&D (Wish List)	Priority	R&D by COE and by Whom?
Policies & Institutional Framework (PIF)		
1. R&D to implement a policy where flow and sharing of information is free of charge	Immediate	SEA
Hazard Mapping and Assessments (HMA)		
Mapping techniques		
1. Effectiveness of relevant mapping techniques for landslide susceptibility, hazard and risk assessments.	Short term	SEA/COE
2. R&D on debris flow hazard prediction to estimate relative susceptibility of valley side erosion to establish threshold for landslide due to debris flow.	Long term	
3. Harmonisation of the Risk Ranking system adopted in TEMAN System by PLUS and SMART system adopted by CKC, R&D to explore further for their application to Federal roads and subsequently on area based problem.	Medium term	SEA
4. R&D on the integration of cost benefit analysis with risk analysis	Long term	SEA/COE
5. Explore the usage of Landslide Risk Management Assessment Report as published by Australian Geomechanics Society (AGS) in Malaysia context. The approach is currently not viable due to the lack of database and detail information on landslide. Hence shall be implemented in long term. It is imperative to adopt qualitative risk ranking system to prioritise resource allocation for slope engineering and management as mentioned in Item 9 of this section.	Long term	
6. Based on the established Traffic Management System for Cut Slope by Japan, ground water content and short term forecast rainfall is adopted for Risk Ranking of slopes via Artificial Neural Network. With the collaboration with Japan after the establishment of a comprehensive landslide inventory, R&D to explore the applicability of such system to Malaysia and to perform cost-benefit analysis on it.	Long term	

Topics / Areas of Required R&D (Wish List)	Priority	R&D by COE and by Whom?
7. To develop better expert judgment on risks and hazards ranking.	Long term	SEA/COE
8. To explore indirect measurement for the mapping of potential landslide areas using terrestrial photogrammetry.	Long term	
9. To establish a framework on the development of qualitative ranking system for slopes.	Long term	
10. To establish quantitative risk assessment framework with availability of landslide database.	Medium term	
11. To consider an integrated approach using both probabilistic and deterministic methods to manage the risks associated with different slope conditions.	Long term	
Supporting Information / Tool		
12. Enhance information database on digitised Malaysian Topographical Map as it is currently lacking, collaborate with JUPEM.	Immediate	SEA, MACRES
13. Based on Hazard Map of Selangor, Pahang, Penang and Cameron Highland produced by MACRES, identify high risk area for detail Hazard Mapping by SEA.	Short Term	
Factors of Hazard & Risk Mapping		
14. Temporal and spatial distribution of probabilistic of the relevant parameters (rainfall, strong ground motion, human disturbance) with vulnerability and intensity/population of elements at risk for landslide risk assessments.	Long term	MACRES, SEA/COE
15. To develop list of possible hazard, ex. Hazard off-site (either uphill or downhill slope), from small but high, frequency landslide to large but low frequency landslide.	Short term	MACRES, SEA/COE
16. Currently recognised data required for Landslide hazard mapping are as follows:	Short term	MACRES,

Topics / Areas of Required R&D (Wish List)	Priority	R&D by COE and by Whom?
• Topographic – angles, orientations, watersheds, stream • Physical geology – tectonic / lithology – bedding, erobility. strength • Geomorphology – topography, geology, adverse features (broken drains, pending, discontinuity, seepage) • Soil information – erodibility, weathering grade and depth, freedom of drainage, cohesiveness • Climate – rainfall, ground water change • Present & antecedent Land Use / Vegetation • Current status of erosion • Hydrology – stream bank erosion hazard estimate R&D to explore the sensitivity of each governing factor and to identify a weighing scale to the above factors to facilitate the production of Hazard Map. With additional vulnerability analysis on population or intensity of elements at risk, Risk Map can be produced from Hazard Map.		SEA/COE
17. To verify ROSE Index & Risk Calendar published by UiTM, in particular on its contributory factors. The information to be made public for common usage after verification.	Medium term	UiTM, SEA
18. R&D on groundwater Hydrological Modelling for pore water pressure monitoring which affect Hazard Mapping and subsequent threshold for early warning.	Long term	SEA/COE
Early Warning and Real-Time Monitoring System (EW)		
Rainfall-induced landslide 1. Mechanism of sharing of available resources, e.g. Rain gauges with JMM, JPS to setup complete system. 2. Correlation of antecedent rainfall data to landslide at different geographical zonings.	Immediate Continuous effort	SEA, JMM, JPS

Topics / Areas of Required R&D (Wish List)	Priority	R&D by COE and by Whom?
3. Types of rainfall-induced landslide and its mechanism.	Immediate	SEA/COE
4. Threshold of soil saturation to initiate debris flow.	Long Term	SEA/COE
5. Statistics of run-out distance and angle of debris flow in Malaysia.	Medium Term	SEA/COE
6. R&D on the empirical relationship between Rainfall Intensity and duration	Medium Term	Meteorologist
7. From the pilot study done at Ampang area to establish rainfall – landslide curve as a tool for early warning system, R&D to extent to other high risk area, e.g. Gombak and Petaling Districts.	Long Term	SEA/COE, MACRES
Threshold function		
8. Establishment of appropriate threshold functions to various types of landslide for early warning purpose. • Earth slide : Cumulative antecedent rainfall to landslide • Debris flow : Soil saturation and erodibility of slope materials	Short Term	
9. For the establishment of rainfall threshold functions, it is proposed to adopt the threshold functions established by JMM and JPS as reference for the further refinement in the context of landslide. For example, High Risk is definite as greater than 100mm/hr cumulative rainfall since midnight.	Short Term	
10. R&D on landslide (rainfall) threshold function for individual stretch of slope, rather than a generalised function for the entire nation. The establish threshold function shall be based on terrain and geological features.	Long Term	
11. R&D on warning criteria formulated by the Master Plan for further refinement, in particular for Penang and Sabah.	Immediate	
Slope movement prediction		
11. Applicability of landslide movement models as predictive tool for early warning purposes in Malaysia (rapid slope movement and creeping slopes).	Medium Term	SEA/COE

Topics / Areas of Required R&D (Wish List)	Priority	R&D by COE and by Whom?
12. R&D on adopting mud flow camera as a means of slope movement predictive tool, as adopted in Japan for the handling of landslide along roads.	Long Term	SEA/COE
Earthquake-induced landslide		
13. The risk of earthquake induced landslide in East and West Malaysia.	Long Term	SEA/COE
14. Development of landslide trimmer map in Sabah by UMS	Long Term	
15. Seismic design for slopes and subsequently develop a Seismic Induced Landslide Hazard Map	Long Term	
Technology on Landslide Warning Model		
16. As Hong Kong is currently adopting 1000 km^2 as the grid for rain gauges, R&D to explore the most suitable grid for high, medium and low risk areas in Malaysian context, incorporating cost benefit analysis and realistic resources.	Long Term	
17. As landslide warning in Hong Kong is currently made based on prediction of 15 landslides resulting from previous 21 hours and next 3 hours nowcasted rainfall, R&D to explore suitable landslide warning level for Malaysia.	Medium Term	
18. R&D in latest real time monitoring technology, e.g. InSAR, TRMM, Robotic Theodolite	Long Term	
19. The currently available Doppler Radar is able to forecast 90 minutes rainfall with 30 minutes interval. However, as informed by JMM, a technology upgrade will be carried out under the 9th Malaysian Plan to increase rainfall prediction to 3 hours in 30 minutes interval. Hence, R&D to investigate the sensitivity of forecasted information and the accuracy of warning made and proposed the most practical rainfall forecasting duration for landslide monitoring in Malaysia.	Medium Term	

Topics / Areas of Required R&D (Wish List)	Priority	R&D by COE and by Whom?
Loss Assessment (LA)		
Economic Research on Landslide 1. R&D on operational assessment guideline of immediate needs of victims. 2. R&D to evaluate the intangible cost in Malaysian context. 3. R&D on the appropriate time frame for full reassessment of economic and financial impact of a major disaster, their advantages and disadvantages and the usage of assessment for different time frame, e.g. 3-6 months after the event, 18-24 months after the event, 2-5 years of complete loss assessment. 4. R&D to explore the proposed time frame of 6 months by the NSMP. 5. R&D to explore the advantages, disadvantages and limitation of the different type of assessment approach base on the level of detail required, for example: • Rapid assessment / averaging approach • Detailed assessment / Synthetic approach	Immediate Immediate Long Term Short Term Medium Term	SEA/COE/ Economist
Information Collection, Interpretation, Dissemination and Archiving (ICIDA)		
1. Data collection including database or inventory on slopes, landslides, failure consequence, rainfall, geology, subsurface investigation, laboratory test data, etc and bibliography on past researches. 2. Collection for landslide inventory for natural terrain landslide. 3. As SEA is the permanent custodian of Landslide Inventory, regular review & updating of Landslide Inventory is essential.	Immediate Medium Term Continuous Effort Continuous	SEA/COE SEA/COE SEA SEA

Topics / Areas of Required R&D (Wish List)	Priority	R&D by COE and by Whom?
4. To identify data required for slope cataloguing for linear-based slope inventory on top of slope dimension and rainfall historical data. 5. To develop stronger technical support in custom programming of software.	Effort Medium Term	SEA
Public Awareness and Education (PAE)		
1. R&D to identify how much they know about landslide & how to improve the way of information delivery information to public to identify suitable way to deliver message to public as part of loss reduction measures.	Short term	Sociologist
Training (TRN)		
1. To develop training programmes for engineers in planning, analysis, design and maintenance on hill site development. 2. To enhance training in slope engineering and management within existing undergraduate syllabus. 3. To develop training module for SI interpretation.	Immediate Immediate Immediate	SEA/COE SEA/COE SEA/COE
Loss Reduction Measures (LRM)		
Design 1. Current Earthwork Bylaws 1975 has too many irregularities hence not effective. R&D to enhance Earthworks Bylaw regulation for effective enforcement. 2. R&D to expand current prescribed JKR specifications to be site specific. This maybe outsourced to Consultants.	Immediate Immediate	Legal Expert Consultants

Topics / Areas of Required R&D (Wish List)	Priority	R&D by COE and by Whom?
Design		
3. Review and update National Land Code 1965	Immediate	SEA
4. Development by SEA to formalised information required to standardise and streamline approval process. This shall be done with the collaboration and agreement by relevant Local Authorities and related agencies such as DOE etc. Road show shall also be held to educate and train all policy enforcing officers.	Immediate	SEA
5. Develop practical scheme for the policy implementation in terms of geological evaluation of natural terrain to identify advance geological condition and natural ground water flow.	Long Term	SEA
6. SEA to liaise with Malaysian Site Investigators Association for Subsurface Investigation (SI) training and revise SI rates to improve quality of SI works.	Immediate	SEA
7. To compile and implement a policy on provision of surface and subsurface drainage measures	Medium Term	SEA/COE
8. To develop design templates to guide engineers in planning, analysis, design and maintenance on hill site development.	Immediate	SEA/COE
9. To develop guideline on modules for the Interpretation of Subsurface Investigation (SI) Information.	Immediate	SEA/COE
10. To develop guideline on the planning of SI for hill-site development.	Immediate	SEA/COE
11. To develop guideline to enforce and improve supervision of SI works.	Immediate	SEA/COE
12. To develop guideline for hill-site development over depression and valley areas considering the influence of water catchments.	Immediate	SEA/COE
Maintenance		
13. R&D on the relationship between Risk Level and slope Maintenance Inspection Frequency, uses TEMAN system as reference, to establish its effectiveness and possible improvements.	Medium Term	SEA/COE
14. Due to the current lacking of slope maintenance, R&D to setup maintenance guidelines similar to Hong Kong GeoGuide and Australian Guideline for Landslide Risk Management.	Long Term	SEA/COE

Topics / Areas of Required R&D (Wish List)	Priority	R&D by COE and by Whom?
15. R&D on easy maintenance solution.	Medium Term	SEA/COE
16. Research on high-tech system for infrastructure maintenance	Long Term	SEA/COE
17. To propose a system to ensure the implementation of Post Construction Performance Review during Contract Maintenance Period (e.g. monitor GWL for one wet season)	Long Term	SEA/COE
Mitigation Measures		
18. Develop effective and commercial methods for evaluating and retrofitting, existing hazardous settlement or infrastructure whish are subjected to natural and man-made landslide. This may be a field technology.	Medium Term	SEA/COE
19. Develop technologies to diagnose pre and post failure condition of slopes.	Long Term	SEA/COE
20. Develop system of constant review and evaluation of performance standards, procedures, codes for major lifeline systems, ex. Utilities.	Continuous Effort	SEA
21. R&D on the possibility of implementing insurance scheme specially design for damage cause by slope failures.	Medium Term	Insurance Firms
Emergency Preparedness, Response and Recovery (EPR)		
Preparedness 1. To develop post-incident analysis model of landslide for improvement of emergency management of landslides.	Medium Term	SEA

Topics / Areas of Required R&D (Wish List)	Priority	R&D by COE and by Whom?
Response 2. R&D on Geophysical survey, e.g. seismic instrument like ground penetrating radar to detect buried victims. 3. R&D on Geotechnical instrumentation to timely monitor slope movement and hence, to ensure safety of rescue personnel. 4. Research on high-tech system for emergency damage control and service restoration **Recovery** 5. Develop technology for rapid rehabilitation after failure.	Long Term Long Term Long Term Long Term	Geo-physical Engineers Engineers SEA, Engineers
Research & Development (R&D)		
Characterisation of Slope 1. General engineering characteristics of the superficial weathered slope materials derived from various geological formations in Malaysia. 2. The consequence and identification of inherent relict geological discontinuities in landslide mitigation measures. 3. R&D on water infiltrations into soil in terms of volume, for difference material / particle distribution. 4. Compilation of a summary of soil index properties obtained from case studies (LL, PL, PI, etc) and strength parameters (c', ϕ') 5. To propose a comprehensive programme to produce improvements in in-situ characterisation, laboratory	Medium Term Medium Term Short Term Short Term Short Term	SEA/COE

Topics / Areas of Required R&D (Wish List)	Priority	R&D by COE and by Whom?
tests for characterisation and field studies	Short Term	
6. Propose a system to ensure adequacy of engineering geological input to the site investigation, ground model for stability assessment and design verification during construction (including detection of impermeable layer / clay seam and perched water)	Medium Term	
7. Explore the effects of clay mineralogy (either kaolinite rich or montmorillonite rich or others) on the slope stability	Long Term	
8. To carry out fundamental studies into slope creeping movement	Medium Term	
9. Compilation of database on relationships between degree of weathering and bedrock and material strength		
10. Study influence of weathering on physical, chemical and geotechnical properties of soil and rock in the initiation of slope instability	Long Term	
	Long Term	
11. To establish predictive understanding of the effect of low strength slickensided surface on slope stability	Immediate	SEA/COE
12. To develop simplify method of obtaining geotechnical design parameters required for analysis both in for crude estimates and accurate estimates.	Medium Term	
13. To develop method of predicting ground water fluctuation especially during monsoon.	Medium Term	
14. Determine which processes dominated for Malaysian soils; brittle or non-brittle		
15. Determine whether "Saito Linearity" applies for Malaysian landslides		
Landslide Case Studies	Immediate	
12. Compilation of failure mechanism more relevant to Malaysia.	Short Term	
13. Knowing the relevant failure mechanism and to recommend the best methods of rectification works.	Short Term	
14. R&D on the definition of large landslide in Malaysian context by referring to Hong Kong's definition (Hong Kong definite large landslide as displaced volume ≥ 800 m^3 based on information compile by Halcrow China		

Topics / Areas of Required R&D (Wish List)	Priority	R&D by COE and by Whom?
Ltd in collaboration with Hong Kong University)	Short Term	
15. Study the mechanism of debris flow initiation on natural slope and prevention	Short Term	
16. Compilation of literature review on frequency, landslide risk, magnitudes and consequences of slope failures, correlation of rainfall data and slope deformation		
Engineering Stability Assessment		
17. Strength reduction model for slope instability assessment with continuous transition from unsaturated condition to partial or full saturation.	Short Term	
18. R&D on minimum Factor of Safety (FOS) for slope stability considering potential losses, similar to Hong Kong GeoGuide	Medium Term	
19. Explore "reliability engineering" to deal with failures and uncertainties	Long Term	
20. To explore feasibility and possibility of assimilating Monte-Carlo Type Probabilistic Analyses into existing approach for localised problematic area where sufficient subsurface information and historical data are available	Medium Term	SEA/COE
21. By adopting Monte-Carlo Type Probabilistic Approach, compare the impact for various uncertainties (i.e. uncertainties due to measurement of soil properties, spatial variation of soil properties / rock parameters and model uncertainty) onto landslide prediction, where virtual random field of c_u , c' or ϕ' can be generated as input for slope stability for localised problematic areas.	Medium Term	
22. Compilation of the other methods of probabilistic simulation for both soil and rock slope stability assessments	Long Term	
23. Compilation of database which includes back analyses of soil strength parameters from slope failures	Long Term	
24. Simulation and modelling of rockfall path, 3-D analysis technique via Distinct Element Method where it is able to consider the lateral dispersion of block trajectories	Long Term	
Dynamic Landslide Prediction	Short Term	
25. R&D on landslide prediction model for large and complex failure / movement which are too costly to rectify	Medium	

Topics / Areas of Required R&D (Wish List)	Priority	R&D by COE and by Whom?
26. Compile statistics of tell-tale sign of slope failures based on aerial photograph and determine the features (especially debris lows) before slope failures	Term	SEA/COE
27. To explore the soil moisture content measurement using reflectometer (developed by Scientific Campbell) and study its changes with soil saturation from rainfall infiltration	Long Term	
Meteorology and Climate change		
28. The effect of climate change on precipitation pattern in Malaysia. May adopt similar studies conducted by Salmah et al, (2007) of the National Hydrological Research Institute of Malaysia (NAHRIM) as reference where the climate change in Peninsular Malaysia was studied by simulating historical and future projection of weather pattern.	Medium Term	
29. Correlation of relevant meteorological data (rain gauges, weather/Doppler radar, satellite imagery) to temporal/spatial rainfall distribution and intensity.	Medium Term	
30. Accuracy and its potential improvement of the use of hydro-meteorological data in landslide prediction.	Long Term	
Technology Development and Innovation		
31. Slope stabilisation/strengthening measures and their effectiveness.	Short Term	
32. R&D on the usage of subsoil drainage system, in terms of testing (simulation / physical) for effectiveness, pipe interval (cost & benefit), sizes, configuration.	Short Term	
33. Physical modelling of slopes failure with vegetations to develop as a prevention techniques, possibly as a prevention technology to climate change	Medium Term	
34. R&D for practical implementation of slope stabilisation by re-vegetation. This is to prevent the slope from direct rain drop impact, reduce velocity of surface run-off, prevent erosion, enhance natural attractiveness, improve infiltration and improve sediment retention.	Long Term Medium	

Topics / Areas of Required R&D (Wish List)	Priority	R&D by COE and by Whom?
35. R&D on the effectiveness of the currently available erosion control method: o by erosion mitigation technologies – erosion control blanket / mulch, bonded fibre matrix, reinforced turf o by sediment control system o by vegetation rapid rehabilitation scheme	Term	SEA/COE
36. R&D on the technical effectiveness, ease of installation and maintenance for preventing rock fall by rock-sheds, fencing and netting	Medium Term	
37. To collaborate with Hong Kong and Japan research institutes on the slope stabilisation techniques	Medium Term	
38. To study the effect of rock scaling on the stability of the remainder of rock face	Medium Term	
39. To study applicability of continuous sampling using triple tube core barrels with air-foam or other efficient medium	Medium Term	
Future Needs Due to Social Change 40. National Physical Plan (NPP) provide guideline and national framework on geographical distribution of physical development, this shows the concentration of population and infrastructure for prioritising resources based on future needs.	Medium Term	